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CONSTRUCTION AND EQUIPMENT

No. 63

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CONSTRUCTION MACHINERY

MINSTROYDORMASH MACHINERY PRODUCTION PLANS FOR 1982

Moscow STROITEL'NYYE I DOROZHNYYE MASHINY in Russian No 2, Feb 82 (signed to press 4 Feb 82) pp 1-4

[Article by V. K. Rostotskiy, first deputy minister of the Ministry of Construction, Road and Municipal Machine Building: "1982 in Minstroydormash"]

[Text] The USSR Council of Ministers has confirmed the state 1982 plan for economic and social development of the USSR, including the plan for enterprises and associations of the Minstroydormash [Ministry of Construction, Road and Municipal Machine Building], which have begun fulfilling it.

The USSR Council of Ministries, following the decisions of the 26th CPSU Congress and the positions and conclusions put forward by Comrade L. I. Brezhnev, general secretary of the CPSU Central Committee and chairman of the Presidium of the USSR Supreme Soviet, in the CPSU Central Committee's accountability report to the congress, made it incumbent upon ministries to develop and implement measures for fulfilling and overfulfilling established tasks.

The ministry's enterprises and associations, in discussing the tasks of the plan, have adopted a counterplan and socialist pledges: to overfulfill the state plan in 1982 by R15 million.

As of 1 January 1982 calculation of plan fulfillment is conducted on the basis of net production norms or only on the basis of labor input of every collective without calculating the value of raw materials and sets of products that are included in the value of commodity production. The new method of calculation makes it possible to show more precisely the contribution made by every worker's collective to the overall volume of production in the country.

It is planned to increase labor productivity by 3 percent in 1982 compared with 1981.

Products of high quality category will total 29.5 percent, including 41.5 percent of excavators, 53.9 percent of tower cranes and 26 percent of road graders.

The 1982 plan calls for the production of 37,420 single-bucket and multibucket excavators with bucket capacity from 0.25 to 2.5m^3, including 435 units adapted to the north and 3,080 units of chain and rotary bucket excavators.

It is planned to produce 16,060 truck cranes, including 8,930 units with carrying capacity of up to 10 tons, 7,130 units with carrying capacity of 10 tons and more and 890 cranes on special chassis.

The Voronezh Order of the Red Banner of Labor Excavator Plant imeni Komintern will produce 50 crawler-mounted cranes with carrying capacity of 60 tons. The Volga Order of the Red Banner of Labor "Volgotsemmash" Cement Machine Building Plant will produce 40 crawler-mounted cranes with carrying capacity of 100 tons, which were produced for the first time by the plant in 1981 and it will also begin production of crawler-mounted cranes with carrying capacity of 63 tons.

A total of 2,950 tower cranes with carrying capacity of 5 tons and more will be produced, including 1,982 units with carrying capacity of 8-10 tons and 98 units with carrying capacity from 12 to 25 tons.

A total of 6,000 single-bucket and multibucket construction loaders and 21,500 elevators, including 18,050 passenger elevators will be produced.

In 1982 it is planned to produce 45,500 bulldozers, including 935 units on tractors of traction class 15 (180 horsepower) and 755 units of traction class 25 (330 horsepower). A total of 420 bulldozers on wheel tractors will also be produced.

There are plans to produce 8,860 scrapers, including 83 self-propelled with bucket capacity of 15-25 m^3 and 200 semitrailer ones for wheel tractors. It is also planned to produce 6,600 motor graders, 250 elevating graders and 450 trenching machines.

For the first time in 1982 it is planned to produce the first batch (20 units) of automatic manipulators with programmed control (industrial robots).

Production of hydraulic cylinders and hydraulic automatic equipment for completing machines and equipment with hydraulic drive is continuing to develop.

The volume of production of hydraulic equipment will reach almost R100 million in 1982, including production of almost 140,000 hydraulic motors and 21,600 pumps. The ministry has organized the specialized all-union production association Soyuzstroygidromash for the production of hydraulic equipment and hydraulic cylinders.

For land improvement work in draining land by the trenchless method, the Soyuzmeliormash Production Association plans to produce 60 highly productive MD-4 and MD-5 machines, which will make it possible to cut slots up to 1.8 m deep in I-III soil category without breaking the trench and without backfilling it while continuously laying 50-90 mm diameter plastic drainage pipes in slot bottoms as the machine moves along (the machine's productivity is 1,000-2,000 m per hour, shift output reaches 5,000 m) and 50 mole draining machines for DT-75 B tractors.

Production of canal-cleaning machines for 50-75-180 horsepower tractors to take care of operating soil-reclamation canals will be continued. It is planned to produce 350 such machines in 1982, including 160 selfpropelled ones.

For work connected with preparing the land area being drained some 3,200 stump pullers and collectors and 500 brush cutters on 100-130 horsepower tractors will be produced.

It is envisaged to produce various machines for building canals with concrete walls up to 3 m deep and seven complete sets of machines for constructing enclosed irrigation systems made of 200-400 and 500-1,200 mm diameter pipelines. Some 600 special drawn land levellers for horizontal leveling of land will also be produced.

For hauling cement and bitumen it is envisaged to produce 3,425 cement-hauling trucks with carrying capacity of 8-10, 12 and 24 tons and 900 bitumen-hauling trucks.

To mechanize construction, 500 asphalt mixing installations and 445 asphalt spreaders will be produced; also, 45 complete sets of equipment for the construction of monolithic cement-concrete roads and airports and two complete sets of machines for rapid construction of highways with productivity of 1 km of road per shift; 870 concrete mixer trucks with capacity of 3.5 m^3; and 60 concrete pumping trucks for pumping concrete to the upper stories of buildings under construction.

To mechanize logging work, 2,906 jaw-type loggers, 350 mobile lopping machines, 340 timber-carrying trailer trucks, 400 chip carriers, 650 tree-felling and felling and piling machines will be produced; to mechanize work at lumber yards, 200 tower-type loggers with carrying capacity of 5-10 tons, 220 semiautomatic lines for knot lopping and cross-cutting long logs and 100 automated grading conveyers will be produced. Selfpropelled knot-lopping machines with suspended framework on TT-4 tractors and felling and logging machines with a hydraulic manipulator will be produced. A total of 250 pipelaying machines with carrying capacity of 50 tons on TT-330 tractors will also be produced.

Construction machine-building plants will produce 6,365 construction hoists and 4,800 portable jib cranes with carrying capacity of 0.5 tons.

Some 90,500 tons of industrial equipment and spare parts, including 4,500 tons of reducer pairs for reducers of rotating cement furnaces and tube mills will be produced for the cement industry.

A total of 106,000 tons of industrial equipment for the production of precast reinforced concrete structures and components will be produced.

It is planned to produce 492 mobile crushing and sorting installations, including 410 units of SM-739 and SM-749 models with productivity of 30-40 tons per hour and two automated installations with productivity of 40-50 tons per hour. A total of 68 complete sets of unified installations with a productivity of 250,000 m^3 a year and 2,166 rock crushers, including 117 largest jaw crushers with the size of feed openings of 2,100 x 1,500, 1,500 x 1,200 and 1,200 x 900 mm will be produced by the Volga Order of the Red Banner of Labor Volgotsemmash Cement Machinebuilding Plant.

It is planned to produce 925 presses for the production of bricks and tiles, including 100 units for the production of silica brick.

Fourteen complete sets of industrial equipment with furnaces for the production of pearlite and schungezite and four complete sets of equipment for the production of mineral wool plates will be produced.

Fourteen slate sheet molding machines, 10 complete sets of equipment for the production of flat pressed asbestos cement products and three complete sets for the production of asbestos cement pipes will be produced for the asbestos cement industry.

The output of air conditioners will reach 17,600 units.

The municipal services will receive 20,200 garbage collecting, sweeping, watering and washing, snow removing, watering and other machines, one complete set of equipment for a garbage processing plant, 6,550 fire engines for putting out fires, 3,9-0 engine-driven pumps and 3.2 million fire extinguishers.

The output of cultural, personal and household goods will be considerably increased in 1982.

The Minstroydormash's plan for creating new equipment calls for fulfillment of 764 assignments, including manufacturing 122 experimental models, testing 138 new machines, producing 124 first industrial series (72 machines will be developed for the first time) and removing from production 106 obsolete machines.

Of interest in the first industrial series are single-bucket hydraulic excavators equipped with tractor type caterpillar drive and with bucket capacity of 1.6 m^3, pressure trench grab buckets with a hydraulic drive for excavating trenches by the "wall in the soil" method and equipped with a bucket having a capacity of 1 m^3 when the depth of excavation is 20 m and drilling machines on EO-5122 excavators for drilling 650 and 1,000 m diameter holes up to 20 m in depth in frozen and permafrost soil. The Kalinin Excavator Plant will produce a large series (400 units) of SP-71 hydraulic hammers with impact energy of 300 kilogram force per meter for loosening frozen soil and the Kovrovskiy excavator plant will begin producing hydraulic hammers with impact energy of 900 kilogram force mer meter for hydraulic excavators with a bucket having a capacity of 1 m^3.

The Ivanovskiy Order of the Red Banner of Labor Truck Crane Plant will begin producing new hydraulically operated truck cranes with carrying capacity of 16 tons.

The Slavyanskiy Construction Machinery Plant imeni 25th CPSU Congress will begin producing ready-mix delivery trucks with body capacity of 8 m^3 on a semitrailer attached to a KamAZ truck tractor.

The Tuymazinskiy Ready-Mix Delivery Truck Plant will produce a series of hydraulically operated mix-pumping trucks with a distributing rising boom able to rise to 20 m and having productivity of 60 m^3 per hour.

The Balakovskiy Plant will produce 25 selfpropelled two-motor scrapers with bucket-holding capacity of 15 m^3 on a BelAZ-531 single-axle truck tractor. The same plant will produce bulldozers for T-330 tractors and will manufacture experimental-industrial models of DZ-107-1 two-motor scrapers with bucket-holding capacity of 25 m^3.

The Berdyanskiy Order of the October Revolution Road Machinery Plant will develop production of semitrailer scrapers with bucket holding capacity of 4.5 m^3 for T-150 wheel tractor of traction class 3. The same plant will produce the first series of single-bucket pneumatic wheel loaders with carrying capacity of 15 tons and power capacity of 540-650 horsepower.

The Orlovskiy Road Machinery Plant will produce a large series of medium-type motor graders with 135-160 horsepower diesel capacity.

High-capacity milling-rotary snow-blowers with a productivity of more than 100 tons per hour on a K-701 wheel truck tractor will be produced by the Severodvinskiy Road Machinery Plant.

The plants of the Soyuzstrommash All-Union Production Association will produce a set of industrial equipment (33 machines) for an automated plant engaged in the production of structural clay tiles and a complete set of equipment for a highly mechanized plant engaged in the production of reinforced concrete structures for large-panel house construction with annual productivity of 180,000 m^2. The Mogilveskiy Order of the Red Banner of Labor Strommashina Plant imeni 50th Anniversary of the Great October will manufacture a complete set of equipment for the production of wood chip boards as well as some other complete sets of equipment.

The plants of the Soyuzkommunmash association will produce 10 complete sets of automatic, flow line equipment for laundry washing with productivity of 850 kilograms per hour using effective detergent; it will also produce new wringer washer machines.

Fire-fighting equipment manufacturing plants will produce the first industrial series of seven new models of fire engines in 1982 alone.

The newly constructed Vokovysskiy Roofing and Construction Finishing Machine Plant will produce 150 painting stations for comprehensive mechanization of painting work with productivity of 500 m^3 per shift.

The new Dneprorudnenskiy Construction Finishing Machine Plant will manufacture a batch of mobile plastering stations with productivity of 2 and 4 m^3 per hour.

The Vilnyusskiy "SOM" Construction and Finishing Machine Plant will produce the first series of semiautomatic pneumatic nail-driving machines (500 units) and semiautomatic pneumatic stapling machines (500 units) used in mass production of prefabricated wooden houses.

Plants of the Soyuzliftmash association will deliver the first batches of monorail freight elevators with carrying capacity of 1,000, 2,000 and 3,200 kilograms and speed of 0.5 mps.

In 1982 it is planned to stop production of 106 machines of obsolete design: EO-6112B excavators with mechanical drive, KB-401A tower cranes, complete sets of D-508-2A equipment used in the preparation of asphalt concrete mix with productivity of 25 tons per hour, manually controlled KP-011 washing machines with productivity of 50 kilograms of laundry per hour, manually controlled Ts-10 centrifuges with the same productivity, two kinds of manual carbon-dioxide fire extinguishers and other machines and equipment.

In 1982 great goals are set for the introduction of advanced technology, mechanization and automation of production processes.

Production of castings by a comprehensively mechanized method must total 604,000 tons in 1982 and of forgings and stampings 91,000 tons. The volume of comprehensively mechanized production of welded structures will reach 810,000 tons. Production will begin for the first time of billets, obtained by the hellical and cross-wedge rolling method on a mill made by the Soyuzstroymashavtomatizatsiya Association.

In 1982 it is planned to introduce 14 automatic and semiautomatic lines and 50 mechanized flow and conveyor lines.

The level of mechanization and automation of welding work will reach 83 percent of this work's overall volume.

Three hundred ChPU metal-cutting machine tools and 10 automatic manipulators with programmed control will be introduced.

One of the main tasks of all enterprises of the Minstroydormash is to reduce expenditure of materials for every type of product turned out. In 1982 it will be necessary to reduce the input norms of ferrous rolled stock for all goods produced by 3.9 percent, for rolled pipes by 2.25 percent, for drawn pipes by 4.5 percent and for thin-walled seamless carbonic tubes by 5 percent. At the same time the utilization ratio of rolled stock must reach 0.77.

For 1982 the ministry has confirmed an integrated program of manual labor mechanization at enterprises that provides for releasing 24,100 workers from manual labor and which will yield an economic effect amounting to R16.1 million. To fulfill the program, it is planned to acquire R49 million worth of means of mechanization and equipment and also to produce R33 million worth of nonstandard equipment. As a result of fulfilling the outlined measures the relative share of manual labor at the ministry's enterprises will be reduced from 29.2 percent in 1981 to 28 percent in 1982.

Among other measures, it is planned to introduce automatic complexes with industrial robots in forge shops; expand production of castings in molds which do not require (KhTS, ZhSS) type packing and vacuum molding; and equip production with means of small-scale mechanization, cantilever-rotary cranes, positioners, manipulators and other means.

In the assembling shops it is planned to use local means of transportation, nonstandard equipment, mechanized tools and manipulators in assembling excavator working chains. In loading and unloading, transportation and warehousing operations, it is planned to expand the use of forklift trucks and electric loaders equipped with load-handling devices, standard unit packing, pallets and containers.

Altogether it is planned to introduce 195,000 such units during the 11th Five-Year Plan. By 1985 the degree of manual labor mechanization should increase to 65.2 percent, and the relative share of manual labor should decrease to 23.7 percent. A total of 12,300 workers will be diverted from manual to mechanized labor.

The ministry plans further expansion of some plants and shops, among which one may mention block No 4 covering the area of 6,300 m^2 at the Kalininskiy Excavator Plant which will be commissioned in the fourth quarter of 1982 and is rated to produce 500 excavators; a production shop covering an area of 25,000 m^2 at the cement-hauling truck plant in Tuymayzy City; completion of construction of the pipe-laying machine shop at the Sterlitamakskiy Construction Machinery Plant; the assembling and welding block covering an area of 12,000 m^2 at the Sverdlovskiy Timber Machinebuilding Plant; a shop covering an area of 14,800 m^2 at the Uchalinskiy Timber Machinebuilding Plant; a machine assembly shop covering an area of 5,200 m^2 at the Torzhokskiy Machinebuilding Plant; and other projects.

Collectives of the Minstroydormash started the second year of the 11th Five-Year Plan with confidence and are fully resolved to fulfill and overfulfill the state plans.

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METALWORKING EQUIPMENT

ROBOTICS: DEVELOPMENTS, APPLICATIONS OUTLINED

Kheynman on Automatization, Manipulators

Novosibirsk EKONOMIKA I ORGANIZATSIYA PROMYSHLENNOGO PROIZVODSTVA in Russian No 2, Feb 82 (signed to press 31 Dec 81) pp 4-19

[Article by Professor S. A. Kheynman, doctor of economic sciences, USSR Academy of Sciences Institute of Economics, Moscow: "Automation and Automatic Manipulators"; passages enclosed in slantlines printed in boldface]

[Text] Objective reasons have dictated the course toward expanded automation of production operations as outlined by the 26th CPSU Congress. In the first place, by the logic of the development of the scientific-technical revolution and of large-scale machine production, the highest form of which is the system of automatic machines, automated production as one of the most important components of the material-technical base of communism. Secondly, by the continuously growing importance of increasing the productivity of the labor involved in material production. This problem is becoming particularly urgent because of the sharp drop the 1980's will see in increases to the population of working age, the rise in the technical-cultural level of the population and its increasing requirements, the lack of any prestige associated with heavy and unskilled labor and by the need to increase the number of people working in the non-productive, services sector by gradually freeing up those now engaged in the sphere of material production.

The development and growth of automation and its impact upon the nature and efficiency of labor and production operations constitute a process with a number of aspects, a process specific for different branches of production. In expanding horizontally, becoming more extensive, automation is being introduced into an increasingly broad range of processes, facilities and branches; in penetrating down, vertically, it is coming to encompass an increasingly large number of functions and operations, both primary and secondary.

EKO has already published a collection of articles dealing with such an important element of automation as machine tools with NPC [numerical programmed control].*
In publishing in this issue a selection of articles on the problems associated with the development, production and introduction of automatic manipulators (industrial

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* See EKO, No 6, 1977.

robots), EKO editors are continuing their discussion of the status, outlook and problems of automation.

The entire range of questions involved here should be seen as a component part of an integrated, goal-oriented program for the development and introduction of an automatic machine system (one of the subsystems of which is automatic manipulators) designed for a prolonged period of Soviet economic development.

In "Basic Directions in USSR Economic and Social Development for the Years 1981-1985 and for the Period Extending to 1990," the 26th CPSU Congress set forth some very large-scale tasks in the sphere of progress in automation: "...develop production and introduce extensive application of automatic manipulators (industrial robots) and built-in automatic control systems incorporating microprocessors and microcomputers and develop automated shops and plants." Taking into account both domestic and foreign industrial practice, we attempt in this article to outline the general process of automation and the role automatic manipulators (robots) play in this process.

The Scope and Stages of Development

Automation, that is, the development and utilization of mechanical devices for the application of fundamentally new methods of controlling means of labor, conforms to its own principles and exhibits its own characteristic trends; its development encompasses a number of stages, which, while differing in technical and organizational level, in a number of instances coexist in time. Each of them has its own impact upon the structure and nature of the production process and the socioeconomic aspects of labor.

/The early stages see automation of the collection of information concerning the parameters of production processes./ As early as the 20's and 30's of the 20th century, KIP [control and measuring instrument] services were functioning in continuous, unit-production operations such as metallurgical, petroleum-refining and chemical plants. While it freed the worker from responsibility for directly taking readings characterizing the course of the production process, this stage of automation left him with the functions of analysis, making the necessary decisions and then performing the appropriate management functions.

/The next stage saw the appearance and introduction of automatic control devices for machine tools and other types of industrial equipment./ These devices initially functioned in accordance with a rigid program without feedback, this function still being performed by the human worker-operator. Further progress in automation, made possible with the development of electronics, came with the appearance of automatic control devices functioning in accordance with the "closed loop" principle, that is, feedback. In this stage the human operator retains functions associated with monitoring the state of machinery: he is now freed from responsibility for direct control of equipment.

Parallel to this process, which directly affects basic production units, /automation is now extended to take in the function of controlling equipment associated with the entire range of secondary processes/, most importantly to the movement and transportation of the objects, means and products of labor and technical monitoring of the state of an object of labor and of instruments and equipment. Now added to these processes are the development, introduction and improvement of industrial manipulators (robots). This extension of the sphere of automation to encompass secondary processes is of fundamental importance. It constitutes the first step in the transition from automatic control of individual units to the creation of automatic lines, that is, to the full automation of production operations, and makes possible a sharp decrease in production labor intensity by eliminating a large number of auxiliary workers engaged in manual labor. Of prime socio-economic importance is the fact that what we are talking about here are unskilled, monotonous (to include assembly operations) and for the most part manual operations, which are the least tolerable for today's worker, as well as processes whose conditions exclude the possibility of a human presence.

Since automatic manipulators are widely employed as organic additions to production units and lines, they create conditions for the performance of tasks which are very important with respect to both the technology and efficiency of production operations--the precise positioning of objects and means of labor, thus permitting optimization of the production process itself. The importance--both technical-economic and social--of automatic manipulators is thus exceptionally great.

In all its manifestations, automation is the control of various mechanical devices. Hence it follows that the mechanization of production--complete mechanization, that is, encompassing both primary and secondary operations--constitutes an indispensable precondition for automation. As we see, the course the 26th CPSU Congress has set toward an intensification of automation is in a way acting as a catalyst of complete mechanization.

/As we see it, further progress in automation over the foreseeable long term will proceed in three basic directions./

/First,/ improvement of feedback systems incorporating increasingly advanced electronics and microprocessors. What we are referring to here are adaptive automatic devices; efforts in the direction of increasing the complexity of program components and servosystems and of the links between them; the use of today's great variety of hardware for generating, recognizing, processing and using information; the technology associated with what is referred to as the "sensitization" of automatic devices, which makes it possible to check the condition of the production environment and the parameters of process and working tools and to replace them if necessary and the technology associated with servomechanisms, sensors and the ever-increasing variety of control devices and systems.

/The second direction/ involves the development of flexible means of automation which can be adapted to accelerated, due to advances in science and technology, replacement of systems and of the objects and products of labor. What is referred to here is automatic equipment with NPC making it possible to use the same equipment to process different objects and produce different articles. This direction is of vital economic importance; in this direction we find to lie the solution to one of the fundamental and most contradictory problems of scientific and technical progress--the combination of a systematic increase in the complexity and specialization of machines and equipment and the continuously increasing frequency with which product models are changed. Development of these trends can be seen to lie in the creation and rapid introduction of what are referred to as "processing centers" with NPC and of multifunction machine systems specially equipped for medium-scale, small-scale and single-unit, custom production and automatically transporting and repositioning objects of labor, actuating and replacing working tools and performing production and monitoring operations. The complex electronic control devices are external to the processing system itself and are linked with it via special interfaces.

The /third clearly identifiable direction in automation/ (the one of perhaps the most fundamental importance) involves the modeling and optimization of production processes at all levels of the production hierarchy. By virtue of the fact that it fundamentally improves both the technology and organization of production, this direction extends beyond the sphere of the means of labor proper. The development and employment of analog computers and the emergence of a whole series of scientific disciplines encompassing programming, operations analysis, game theory, systems theory and systems engineering and with applied mathematics generally have introduced a powerful new factor increasing the productivity of social labor--the development of optimum variants of production technology and organization and the management of production operations within these optimum regimes.

What we are referring to here are trends which see automatic equipment playing a role formerly played only by human beings doing intellectual work, it being demonstrated that it does it qualitatively better and more efficiently. The important characteristic of this trend consists in the fact that it introduces complex automatic equipment directly into the processes of intellectual work. This constitutes a graphic demonstration of the supremely important provision of the program concerning combination of intellectual and physical labor in human productive activity.

The Automatic Machine System

Taking as a basis the present level at which production has been automated, we can thus outline the following structure of the implements of labor employed in automated production, a general structure for branches engaged in continuous production as well as those with discrete production and processes such as those to be found in the machine-building industry. This system of machines will obviously comprise three components.

The first component will be the automatic and automated working machines equipped with feedback devices. The second, cybernetic and information machines, as a rule, electronic modeling, computing and control machines performing planning, production-engineering and optimization computations, determining optimum regimes and conditions for production operations overall as well as for individual units and machines and generating correcting and control decisions and instructions. The third element comprises the system of servomechanisms and devices transmitting the control and correcting pulses to the working machines in accordance with the feedback principle.

The first element of our system should be seen viewed as the broadest possible range of industrial equipment as well as machinery employed in the secondary processes of transportation, movement, technical monitoring, packaging and storing in the most varied branches of production. It is precisely this component of our system that encompasses automatic manipulators (industrial robots).

The second and third components of the system offer a wide field for the fruitful standardization, unification and normalization of both cybernetic and servosystems.

Modeling and control devices and servomechanisms performing feedback functions may be seen as transmission devices of the age of automation. The creation, not to mention the functioning, of these two components remain today in only the initial stage of their development. Despite the fact that their acronym contains the letter "C" for "control," many ACS [automatic control systems] as a rule still do not control, but rather perform an electronic-information-processing function. A great cooperative effort on the part of scientists, engineers and economists will be required for these components to perform truly control functions. This is tedious, painstaking work, highly specific for each branch of industry.

Taking into account this characterization of the trends and stages of automation, we should now look at the processes actually occurring in this sphere and the conditions preparing domestic production operations for effective assimilation and exploitation of the potentialities of automation.

Cut According to the User Pattern

We should emphasize here the special importance of matching the potentialities of automation and the "requirements" of automatic equipment with the production conditions, requirements and resources obtaining where it is to be introduced. Automatic equipment and automation have to be "cut according to the user pattern." We should not be acquiring the most advanced, sophisticated automatic equipment for reasons of prestige, or because "it's the fashion," which unfortunately, however, proves fairly frequently to be the case. More particularly, we should not install robots for appearances' sake where they yield no benefit. We have to take a good thorough look at both the social and the purely economic aspects of automation.

In introducing new equipment and mechanizing and automating its production operations, socialist society cannot be guided by considerations of pure, "unadulterated" profitability or by the ratio of cash outlay to yield. For such social benefits as making work easier and more interesting and meaningful and creating in the worker a sense of satisfaction with the work process itself, socialist society can, and in a number of instances, must pay. Provision of these benefits must be viewed not simply as a portion of expenditures, but rather as an integral component of the results of production.

For the human being, creative labor is no less important than satisfaction of material and spiritual needs.

For socialist society, the means of mechanization and automation are in this sense not only the means of labor, but the "product"-result of social production, enriching and expanding the whole spectrum of the people's well-being and raising their standard of living. The fact is that work time accounts for half a worker's waking hours. We have not yet learned to estimate the "use value" of this good, but it does not thereby cease to be such.

At the same time, in the course of this transition to extensive production automation socialist society cannot remain indifferent to either the magnitude of the social labor costs involved or the economic benefit to be derived therefrom. This also holds entirely true for automatic manipulators, which will have to be manufactured and introduced on an increasing scale in industry and other branches of our economy.

/Organization of the production of the means of automation itself and the creation of conditions for their effective utilization with respect to both time and capacity are accordingly assuming vital importance./ This is all the more important, what with the fact that, as a rule, automatic equipment is substantially more expensive than conventional types.

A systems approach to automation must be adopted as early as the stage at which means of automation are planned and designed. As we can see from practice both domestic and foreign, to include that in developed capitalist countries, a course toward automation based upon processes associated with existing technology and production organization does not yield the desired benefit and in a number of instances leads to an increase in specific production costs.

Particularly if we are speaking not of an individual production unit, but rather of the creation of automatic lines or of the automation of a production facility as a whole, automation has a logic of its own and requires a rethinking, a reinterpretation of the entire process taken as a whole, a change in technologies and the elimination of a number of existing processes, not automation of the production of all assemblies or components of a current design, but rather a rethinking and a modification of the design itself.

Radio electronics would be a good example. To automate the production of radio circuits while at the same time keeping their tube-based design would be either impossible or unthinkably costly. The changeover to printed circuits, that is, to an entirely new technical solution to this functional problem, created the bases for a completely different technology and organization and made possible the full automation of production operations. The switch to integrated and large integrated circuits is bringing with it the same revolution in the engineering, technology and organization of production.

/The entire fund of experience now available thus points to the fact that the planning and design of automatic equipment requires a functional approach, which looks at the best way to perform a given function./ Our magazine has discussed the application of FSA [FVA]--functional value analysis.* It proves particularly valuable in the development of automatic systems. Realization of this approach is inextricably linked with the development of functional specialization in machine building and with the creation of enterprises, associations and branches on the basis of specialized production of functional assemblies for equipment, particularly for automatic equipment. Only on this basis can we realize the highly progesssive outlined in the decisions of the 26th Congress: "In developing new machines, equipment, apparatus and instruments, employ extensively the modular principle using standard units and assemblies."

The development of functionally specialized branches will also constitute the practical realization of the following congress directive: "Continue the expansion of specialization in the machine-building industry and the construction of new and the improvement of existing specialized enterprises and large shops producing billets, parts, units and assemblies for branch and inter-branch use."

Both these directives are a necessary condition for expanding the sphere of large-scale and mass production, which, as is known, are of great economic advantage, and constitute a precondition for cutting expenditures for the operation, maintenance and repair of equipment as well as a condition facilitating the processes involved in modernizing it. They are equally necessary and highly effective in connection with the manufacture of both automatic and conventional equipment.

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* See EKO, No 6, 1981.

What Robotics Specialists are Striving For

In setting forth the task of over the course of the Eleventh Five-Year Plan period developing and organizing the series production of standardized industrial robot modules, which must come to form the basis for the development of robots in all branches of the national economy, the authors of the articles published below dealing with automatic manipulators have adopted valid points of view. "On the basis of approximately 50 basic modules," writes Ye. I. Yurevich, "we can configure industrial robots for virtually all purposes required today."

It is clear that these organizational principles must also be realized in the manufacture of other types of automatic equipment, among others, machine tools with NPC, processing centers and, most particularly, control devices. Data presented in Yu. I. Yurevich's article attest convincingly to the effectiveness of this course.

/In combination with FVA, and based upon an extensive system of functionally specialized enterprises and branches, realization of the modular principle is finding, and will find, a broad resonance./ Scientific and technical advancement in all (to include non-machine-building) branches of social production are seeing the emergence of ideas demanding materialization for a variety of technical improvements and adaptations, including machine tools and other special-purpose units. As we know, our domestic machine-building industry now has almost no "custom sewing shops" which would take in individual orders for the fabrication of nonstandard pieces of special-purpose machinery. What we are seeing are consumer enterprises making them in "their own" machine shops in primitive, out-dated, costly fashion. The main way to solve this problem, of course, is to create these currently nonexistent "shops." But the development of functionally specialized enterprises and the production of modules greatly facilitates and improves the solution of these problems, both with and in the absence of any "shops." Consumer enterprises will be able to materialize their technical innovations on an up-to-date scientific-technical level. The authors of the articles published below deal with this among other things in connection with automatic manipulators. "The manufacture of industrial robots will reduce primarily to their assembly from standard components and can be organized by any ministry."

/The idea of developing "robot systems" (or robotized production complexes) is also a forward-looking one and one having general importance for organizing the production of all types of automatic equipment./ Means of automation must be organically linked with the production environment as a whole, most importantly with primary production facilities and equipment.

Proceeding from analysis of the role of the robot, Ye. P. Popov, corresponding member of the USSR Academy of Sciences, has formulated an approach which applies equally to other means of automation as well: "It is important not only to develop the robot, but also to link and coordinate it with other technical means of mechanizing and automating production."

Realization of this approach will require the joint efforts of both scientists and engineers: a component-by-component, unit-by-unit development of the functional units of this automatic equipment, including its "sensory" and "motor" organs (extremities), its "vision," "hearing" and "speech" (when necessary) and its organs of control as well as a systems-oriented study (review) of the entire production system or engineering process in which or with which this equipment will be functioning. Treatment of the entire chain of operations in which it is planned to introduce automation as a single engineering process and then planning and designing a common servosystem for this process--this is the approach required in introducing robots as components of the servosystem as well as other means of automation.

It is at this point that we come to one of the really fundamental problems associated with the development and introduction of automation, and that is its interaction with the surrounding production environment and, through this environment, with the functioning of the entire economic system.

Automation Imposes Demands

Automatic equipment may be endowed with a variety of the components of an artificial intelligence. As a rule, this requires complex electronic devices which substantially add to the cost of the equipment and complicate the procedures involved in operating it. But the requirement for this "sensitization" and the degree of complexity of the various sensors and "sensory" devices is found to be directly, and frequently multiply, dependent upon the degree of "indeterminacy" of the production process involved. "There are many manual operations which robots are unable to reproduce," writes Ye. P. Popov, "in a less than fully determinant environment, objects not precisely positioned and oriented, work with a set of different objects, assembling them etc." And if these "objects" are not there, if they appear a bit later than programmed and not in the proper shape, without the proper technical characteristics, in the wrong place, or if they don't appear at all...?

Specialists in the field of automation and robot building are developing what looks to us like an important and entirely effective, clear-cut alternative. Deficiencies in production organization ("indeterminacy" from the point of view of the automatic device and its developer) can be surmounted in the process of automation in two ways: through organization of the production engineering environment, that is, creation of conditions of stable and efficient production organization, or through the development of adaptive automatic equipment and adaptively controlled equipment and facilities and providing it with all types of sensors and other devices making it possible for this automatic equipment to "recognize" deviations from any desired procedure and adapt to them.

The problem lies in deciding where in any given instance it would be more advantageous to invest resources. In everyday language, "organization of the production engineering environment" means insuring a level of production organization with respect to both space and time which would be adequate to the requirements imposed by automation.

/It should be understood that serious steps in the direction of automation presuppose a high and stable level of production organization./ Failure to meet this requirement would make necessary the incredible complication of the automatic equipment involved and the expenditure of enormous sums to "sensitize" it so as to enable it to adapt to this disordered environment, which writers refer in scientific language to as "indeterminacy" or one would have to resign oneself to extremely poor utilization of his automatic equipment and, accordingly, to low levels of efficiency.

Completion of the transition to a primarily intensive course of development would be inconceivable without fundamental improvement of the organization of production; as applied to direct production itself this would presuppose strict maintenance of all production relationships--deliveries of what is needed where it is needed when it is needed--between branches, within branches, between enterprises, between shops and between as well as within the framework of individual operations; precise synchronization of the operations of all components linked in the production organization and careful development of all elements comprising the production process. Great advantage is to be derived in this connection from adoption of a micro-element approach to the production process and the equipment involved, the development of micro- and macromodules and standardization of robot system components. All these components of rational production organization are always necessary, and particularly so with automation. /It by no means follows from what we have said, however, that automation must be deferred until such time as an ideal production organization can be established. We want only to emphasize that given the historically and economically essential advance of automation, all production deficiencies will have a substantially more acute, adverse impact upon the efficiency with which means of labor (now more costly than before) are utilized./ From this it follows that problems associated with improvement of production organization, its sequencing and continuity, with respect to both intraplant and inter- and intrashop and external relationships (with suppliers and cooperating enterprises) are becoming increasingly urgent, requiring immediate and optimal solution both where automation is to be introduced and where it is already introduced and functioning.

In connection with the tasks associated with the extensive introduction of automation and enlarging the inventory of machine tools and processing centers with NPC and automatic manipulators there arises yet another very important, and, one might say, the key, problem. Automation constitutes the most important condition, the basis for machine building's transition to a higher (in scientific and technical terms) category. This must be preceded, however, by machine building's setting up and organizing to this end the production on the necessary scales of a variety of equipment, without which it would be impossible to develop automatic equipment and employ it. We cannot say that this is a "vicious circle." Machine building has to insure that industry is prepared for extensive introduction and development of automation. This would apply most directly (in addition to those branches manufacturing automatic production units) to the electrical equipment, electronics and instrument-manufacturing industries above all.

The machine-building industry's tasks and its role in the advance of automation have found most eloquent expression in the articles we are publishing (especially the one by Ye. P. Popov). The list of "arrears" to be charged our domestic machine-building industry and which are responsible for increasing imports and delaying the processes involved in automation is quite extensive. Small high-torque motors (we've been talking about the shortage of these for 10 years now); small electric drives; sensitization sensors equipped with converters for inputting information from them into computers; minicomputers and, of course, a wide range of microprocessors etc. Quite a substantial portion of these "brain devices" for processing centers are now being obtained by way of importation, despite the fact that our industry is fully capable of manufacturing these "brains."

In this connection let us note that, according to data published by the USSR Central Statistical Administration, the production of devices and equipment for automation accounted for 3 per cent of all 1980 machine-building and metalworking production

(5.4 billion out of 179 billion rubles). For the U.S. this figure in 1979 was roughly 6 per cent (36.3 of 609 billion dollars as compared with 5.6 per cent in 1970 and 4.7 per cent in 1965).

One of the central directions by which to bring the USSR's national economy to the most forward positions in science and technology, that is, automation with extensive application of robots, requires integrated, systems-oriented preparation:
- the elaboration of an integrated program for the production of modern means of automation with corresponding development of the dynamic branches of the machine-building industry fabricating this equipment;
- comprehensive systems analysis of the production engineering and organization in those branches and enterprises in which automatic equipment is to be introduced;
- organic linkage of the process and means of automation with all components of the production environment.

It is essential that we proceed in this connection on the basis of what we see as the indisputable proposition that effective introduction and functioning of automated systems is inextricably linked with a fundamental improvement of production organization.

Advances in automation and, most particularly, progress in the introduction of automatic manipulators must tie in organically with the course outlined by the 26th Congress: completion of the process of shifting our economy onto the path of intensive development.

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Robot Present, Future Discussed

Novosibirsk EKONOMIKA I ORGANIZATSIYA PROMYSHLENNOGO PROIZVODSTVA in Russian No 2. Feb 82 (signed to press 31 Dec 82) pp 25-38

[Article by Professor Ye. I. Yurevich, doctor of technical sciences; director of the Central Scientific Research Institute of Robotics and Industrial Cybernetics, Leningrad Polytechnical Institute imeni M. I. Kalinin; scientific director and chief designer on the industrial robot problem for the USSR State Committee on Science and Technology, Leningrad]

[Text] Robots are general-purpose automatic devices for performing mechanical operations. The potentialities of the human being performing physical labor form the model for the robot. It was precisely the desire to replace the human being in this role that first gave rise to the idea of a robot, then to the first attempts to realize it (in the Middle Ages) and, finally, to moden-day robotics and robot building.

The robot consists of mechanical manipulator arms and an automatic control device comprising equipment for processing and storing information (a computer, for example), the robot's "brain," and sensing devices (sensors), the robot's "sensory organs." The robot may also be provided with means of locomotion, to include those in the form of mechanical pedipulator legs.

First-generation industrial robots comprise manipulators with automatic control by wired-in program, such as machine tools with numerical program control (NPC) and other automatic functional production equipment. These robots will continue in service, but by 1985 most of the inventory will consist of second-generation robots with advanced means of sensitization and microprocessor control. Then by 1990 it is most likely that most commonly employed will be robots with elements of artificial intelligence. They are the ones that will be taking the place of part of the workers now engaged in heavy, monotonous labor, including assembly and installation, monitoring and control and adjustment operations in all branches of the national economy.

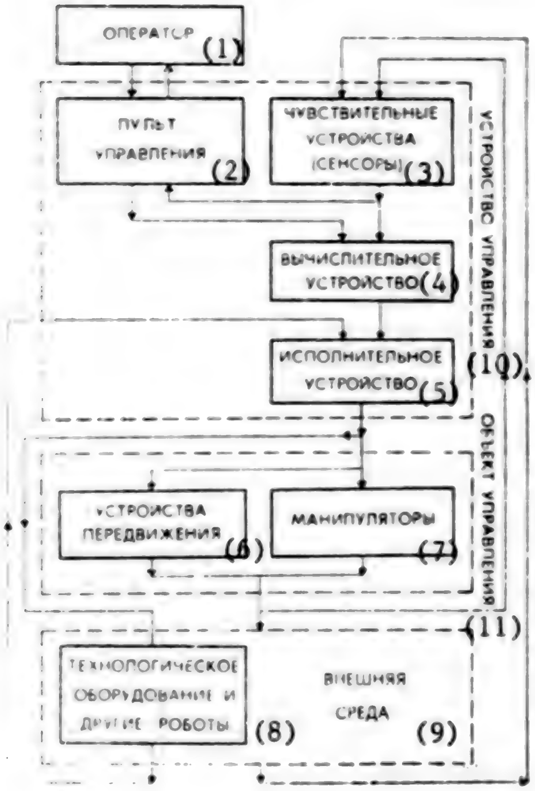
ОПЕРАТОР (1)
ПУЛЬТ УПРАВЛЕНИЯ (2)
ЧУВСТВИТЕЛЬНЫЕ УСТРОЙСТВА (СЕНСОРЫ) (3)
ВЫЧИСЛИТЕЛЬНОЕ УСТРОЙСТВО (4)
ИСПОЛНИТЕЛЬНОЕ УСТРОЙСТВО (5)
УСТРОЙСТВА ПЕРЕДВИЖЕНИЯ (6)
МАНИПУЛЯТОРЫ (7)
ТЕХНОЛОГИЧЕСКОЕ ОБОРУДОВАНИЕ И ДРУГИЕ РОБОТЫ (8)
ВНЕШНЯЯ СРЕДА (9)
УСТРОЙСТВО УПРАВЛЕНИЯ (10)
ОБЪЕКТ УПРАВЛЕНИЯ (11)

Figure 1. Functional diagram of a robot. 1 - operator; 2 - control consol; 3 - sensing devices (sensors); 4 - computer; 5 - - servo device; 6 - means of locomotion; 7 - manipulators; 8 - production equipment and other robots; 9 - external environment; 10 - control device; 11 - object of control

One of the key directions in robot development lies in improving their control systems (with respect to both hardware and algorithmic solutions). Control devices already account for roughly one-half of even the simplest of today's industrial robots. In the immediate future they will be determining both the cost and the basic characteristics of our robots.

Advances in robotics have been determined by actual industrial requirements for full and "adaptable" automation, to include the development of automatic production facilities with a fundamentally new, "nonhuman" production technology. Modern robotics is now more than 15 years old. The world's inventory of industrial robots grows an average of 40 per cent each year and by the end of 1980 had reached some 28,000 units. Our own experience here in the Soviet Union has shown that full utilization of robots already assimilated but far from being brought to their highest state of refinement increases labor productivity an average of 2-3 fold and shift work with production equipment 2 fold; it enhances the continuity and quality of production as well as overall production conditions and standards. Introduction of a single robot yields an economic gain of 8-12,000 rubles annually.

This savings will be all the greater if in computing it we take into account the manpower shortage and the reduction of labor turnover, occupational disease, expenditures for social security etc. This requires that we look at the entire production process into which robots are to be introduced. Development of a better method of determining the economic efficiency of the use of industrial robots is now an urgent problem. Its solution is required to establish a solid basis for methods of achieving further advances in robotics and to solve special problems associated with the automation of production.

A Little History

Over the course of the past 7-8 years our domestic robotics has traversed the path from the development of the earliest experimental models bearing two or three brand names to series production and introduction of several thousand industrial robots carrying dozens of names. We can divide this period of development into three stages.

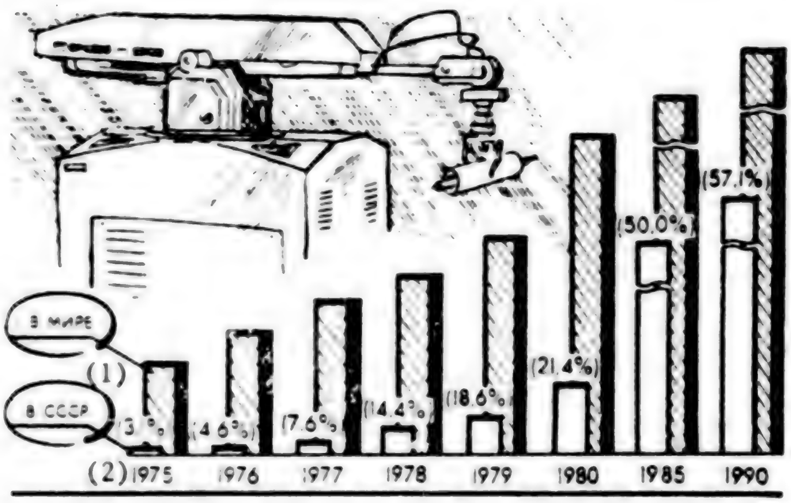

Figure 2. Industrial robot inventory (in thousands of units): 1 - worldwide; 2 - in the USSR.

/The first stage begins back in 1972 with the SCST [State Committee on Science and Technology] decree formulating the problem and setting forth the most important methods to be employed in solving it./ This was followed by approval of the first plan for work on this problem which encompassed 19 branches and departments, to include the USSR Academy of Sciences and higher school. This resulted in the development of more than 30 names in industrial robots suitable for series production.

We can date the second stage as beginning in 1974. Work was continued on the basis of the SCST program for the Tenth Five-Year Plan. Efforts were oriented primarily toward achievement of full unification and standardization in robotics; the development and introduction of new types of robots, to include robots with adaptive control and toward further accumulation of scientific and technical background and experience in this area. Key machine-building ministries were assigned the tasks of developing and manufacturing industrial robots to serve a variety of purposes. The experimental industrial cybernetics design bureau of Leningrad Polytechnical Institute was designated the primary organization. Basic research and development is under the direction of the USSR Academy of Sciences' scientific council on robots and robotics systems.

An initiative on the part of the Leningradskaya, Nikolayevskaya and Vladimirskaya obkoms and the Krasnoyarskiy kraykom of the CPSU led to the development of programs for the introduction and cooperative fabrication of robots within the framework of integrated regional plans for economic and social development. The Leningrad economic region has now taken one of the leading positions in the country with respect to the introduction of robots. Over the last half of the Tenth Five-Year Plan its inventory grew 4-fold and now accounts for more than 10 per cent of the total national inventory.

Series production of industrial robots is now on the rise. More than 100 brands of robots have now been developed, roughly one-half of them currently in series production. We are now developing and introducing series production of standardized control devices. Some 45 per cent of these robots are pneumatic with capacities of up to

10 kg with simple cyclical control; approximately 40 per cent are heavier, hydraulic robots with cyclical to the more complex loop control; the remainder are electromechanical robots of various capacities having a variety of control systems. The technical level of a substantial number of our domestic robots, however, still lags behind that of the best foreign models, chiefly because of the lack or an inadequate number of basic system components (drives, sensors etc.).

The SCST coordinates the development of new models, but interbranch coordination of the development of robotized production systems, their manufacture and introduction have still to be organized to the required extent.

/With the Eleventh Five-Year Plan our domestic robotics is entering into the third period of its development./ Its particular characteristics have been outlined by the CPSU Central Committee decree "Measures to Increase the Production and Insure Extensive Application of Automatic Manipulators in Branches of the National Economy in Light of the Directives of the 26th CPSU Congress" (August 1980). Plans call for extensive introduction of robots in all branches of the national economy, which will yield appreciable results.

Robotics is a new and complex field within the spheres of science and technology. It encompasses the development and manufacture not only of robots and manipulators, but of robotized production facilities in all spheres of the national economy as well. This entails a broad range of organizational, technological, social-economic and even psychological problems. Solution of these problems requires a fundamentally new approach--and frequently overcoming certain established branch traditions, disorganization and lack of coordination. The development of domestic robotics constitutes a typically interbranch problem. It cannot be solved through the efforts of one or two branches alone. All machine-building ministries without exception are themselves to develop and fabricate their own robotized production facilities to meet their own needs as well as the industrial robots accordingly required. Standardized interbranch robot components, the development and manufacture of which will be the responsibility of virtually all machine-building ministries, must be taken as a basis for this effort. Success will depend upon development of an integrated interbranch target program.

Basic Tasks and Ways to Accomplish Them

/The immediate task is to undertake the introduction of robots on an extensive scale through exploitation of accumulated scientific and technical potential and existing productive capacities./

Despite the fact that we have overfulfilled plan requirements for growth of robot inventory, our country is still lagging behind in overall volume, especially as related to production equipment inventory, number of workers in industry or total population. The USSR has roughly 10 robots per 1 million people, for example, while the U.S. has 15, Japan 58 and Sweden 65.

Our inventory and the rate at which we are expanding it do not measure up to the real needs of our national economy. Ministerial requests represent only that portion of actual requirements in terms of known robot brands and the conventional operations they will be performing of which they, the ministries, are "consciously aware." Satisfaction of only these requirements will by 1990 help free up more than 250,000 workers and yield savings of some 1 billion rubles annually. The estimated requirement shown in Figure 3, however, has been computed on the basis of a preliminary analysis of work places taking into account the total inventory of basic production equipment and facilities which could be served by robots and manipulators, the basic production operations which robots could perform and the possibility of future improvement of their technical characteristics. Conversion to adaptive control will thus alone make possible an almost threefold expansion of the sphere in which robots can be applied in machine building. Finally, we must also take into consideration the rapid expansion of the sphere in which robots are being employed in various branches of the national economy other than machine building. Given proper organization, we can speak of replacing some 1 million workers with robots. This will amount to savings of more than 3 billion rubles annually.

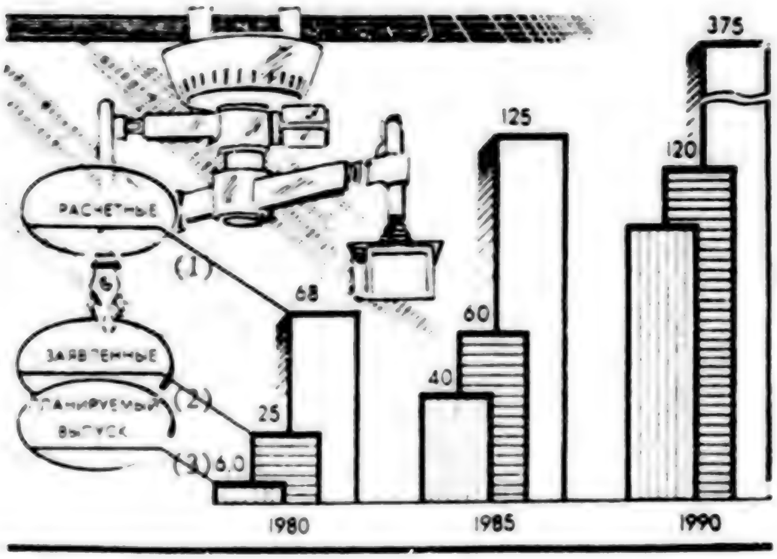

Figure 3. Demand for industrial robots and anticipated robot production (in thousands of units): 1 - - estimated; 2 - announced; 3 - production planned.

How can we intensify the pace at which we are expanding our robot inventory, satisfy the demand for robots to the maximum possible extent and realize the corresponding technical and economic advantage? To simply raise ministerial robot-production targets would not be the proper course to take. This could have negative consequences, to include seeing the whole problem discredited in the eyes of our users. For the fact is that a substantial number of robots are still failing fully to satisfy user requirements. It is to no advantage to increase production of technically inadequate robots.

Over the course of the Eleventh Five-Year Plan we must accelerate the development and then series production of some 50 basic modules (see table), on the basis of which we can assemble robots to meet virtually all of today's needs. This will yield the following advantages.

It will reduce the periods of time required to develop (from 2-3 years to 2-4 months), assimilate and then introduce new brands [marka], what with the fact that they can be assembled from well-tested standard components.

We are now seeing the production of robots on increasingly technically sophisticated levels; their reliability is improving, their cost dropping. The decline in cost is the result not only of the reduction in component cost associated with large-scale production, but also of the elimination of excesses in robot parameters and design.

Standardized Industrial Robot Modules

Component	Level of Complexity	Function
Monoblock	1	Performs structural, drive and information functions with one and two degrees of robot mobility. It comprises modules of lesser decrees of complexity.
Drive module: pneumatic, hydraulic, electromechanical	2	Performs structural and drive functions of one degree of mobility. Robot assembly requires information module and modules of complexity levels 4 and 5.
Servo module: pneumatic, hydraulic, electromechanical	3	Performs the functions of a servo mechanism.
Hardware module	3	Performs functions of control block with drives of modules of complexity levels 1 and 2.
Information module	3	Performs information functions.
Mechanism	4	Mechanisms designed to transmit and convert motion.
Components: assembly	5	Nondrive mechanical components or the simplest hardware assemblies.
part		Nondetachable component robot parts

We will also see declining expenditures for the introduction and operation of robots; maintaining them will be substantially simplified. By being able to add new modules to our robots and by using separate ones as independent production devices (mechanical arms, canting devices, between-operation transport devices etc.), we will find it easier to modernize automated production systems.

Robot production will reduce primarily to the assembly of these devices from standard units and can be organized by any ministry or even a local industry.

The additional economic gain to be derived from conversion to modular robots, which will be possible by meeting branch requirements for 125,000 robots, will amount to at least 145 million rubles annually.

Fabrication of standardized modules will of course require additional capacities. Overall, however, this will yield a substantial saving in capital investment, what with the fact that we will essentially be changing over from the small-scale production of several hundred brands of robots by all machine-building branches to large-scale production of a smaller, stable series of comparatively simple modules by three or four ministries. What is more, these products will fully correspond to their established specialty.

High-quality control devices have a particular effect upon the technical level and efficiency of a robot. Here, too, the most important thing is adoption of a modular principle. As practice has demonstrated, this will cut the period of time required to develop a control device from 2-3 years to 2-3 months, while the economic gain to be derived over the course of the Eleventh Five-Year Plan could amount to at least 65 million rubles. This changeover will make it possible to solve the control problem with respect not only to robots themselves, but to entire production systems as a whole (sections, shops), which will sharply accelerate and at the same time reduce the cost of developing and introducing robots on an extensive scale. A system of modules will require that the Ministry of the Electronics Industry develop and put into series production the appropriate series of microelectronic LSI-circuit components and the same on the part of the Ministry of Instrument Making, Automation Equipment and Control Systems with respect to sensing devices.

Over the course of the Eleventh Five-Year Plan period we will need to develop, assimilate and then introduce at least 20-25 basic robots and approximately 10 basic control devices from standardized modules. A list of the top-priority basic modular robots would include pneumatic robots with a lifting capacity of 0.5 to 20 kg, electromechanical robots with lifting capacities of 0.5 to 100 kg and hydraulic robots with lifting capacities of 25 to 160 kg. To meet immediate needs using basic modules will evidently require the development and assimilation of some 150 modifications on robots and 20 modifications on control devices.

All work on the standardization of robots and their components is undertaken within the framework of USSR Gosstandart's [USSR All-Union State Committee on Standards] unified program for full standardization in industrial robotics.

To meet current needs in robotics it would be desirable to increase production of the best brands developed earlier and proven in actual operation. Important in this connection would be some centralized selection of those of them recommended for series production in the Eleventh Five-Year Plan period. This effort has already been launched by the State Committee on Science and Technology, which has set up an interbranch commission to evaluate robot technical levels.

Over the course of the Eleventh Five-Year Plan period it would be to advantage to increase production of light pneumatic robots some 6-8-fold. Because of their simplicity and low cost they are in the greatest demand, particularly in machine building

USSR Gosstandart Program
of Full Standardization in the Field of Industrial Robotics

Document category	Title	Implementation deadline
Methodological directive (MD)	General Regulations for Robotics	1982
MD	Rules Governing Selection of Facilities for Robotization	1982
MD	Rules Governing the Organization of Work on the Robotization of Industrial Processes	1982
MD	Rules Governing Evaluation of Technical-Economic Indicators for the Employment of Industrial Robots	1982
GOST	Industrial Robots. Terms and Definitions	1980
GOST	Industrial Robots. Categorization	1981
GOST	Industrial Robots. Basic Indicators	1981
GOST	Industrial Robots. Safety Procedures	1982
MD	Industrial Robots. Test Procedures. Regulations Governing Acceptance	1982
MD	Industrial Robots. The System of Modular-Unit Design	1982
MD	Gripping Devices. Categorization. Basic Technical Requirements	1982

GOST	Program Control Devices. General Technical Conditions	1983
GOST	Program Control Devices. Resistance to Interference. Technical Requirements	1983
GOST	Program Control Device. Symbols and Designations	1980
Set of branch technical standards documentation (TSD)	Production Hardware for Robotizing Foundry Operations	1985
Set of branch TSD	Production Hardware for Robotizing Machining Operations	1985
Set of branch TSD	Production Hardware for Robotizing Welding Operations	1981

instrument manufacturing. Production of these robots is of an order of magnitude simpler, while at the same time they free on an average the same number of workers. Simple robots, moreover, are conveniently manufactured cooperatively in individual regions.

As experience has shown, the primary course toward the introduction of robots lies in the direction of the use of standard robotized systems which at the same time include basic production equipment, facilities and operations. The development (including responsibility for the scientific and technical level), production, complete delivery and introduction (to include assembly, installation, turnover for operation and service) of robotized production systems having general industrial application are assigned by plan to individual ministries on the basis of specialty. They themselves then organize for the development and fabrication of special-purpose robots comprising these systems.

Changeover to standard robotized production systems will reduce 3-4-fold expenditures for fully automated production and the periods of time required to develop and realize it. The main way to design standard [tipovoy] systems is to develop standardized [unifitsirovannyy] industrial modules. As far as the development and fabrication of special-purpose robotized systems for intrabranch application are concerned, these will clearly be the responsibility of the individual ministries, which will proceed on the basis of their own requirements.

Our attention should be focused first of all upon systems to perform hazardous operations or operations involving the possibility of injury. These would include, among others, forging and pressing and a substantial number of lifting, transport and loading and unloading operations.

Among industrial production systems in which robots perform basic operations, assembly systems are of particular importance. Despite the fact that these account for a large proportion of overall operations (particularly in machine building), they remain the least automated, what with the fact that traditional methods and means are not very applicable in this instance.

During the course of the Eleventh Five-Year Plan period, all machine-building ministries are to begin work on the development of fully automated pilot shop-level production facilities incorporating robotized production systems and ASUTP [automated systems for the control industrial processes]. These shops, prototypes of future automated plants, will provide unique test facilities in which to work out solutions to technical-economic and organizational problems.

/The second major task of our domestic robotics consists in developing and organizing the production of the robots of future generations, to include robots under intelligent control (what is referred to as artificial intelligence)./ Countries throughout the world have made substantial progress in this area, inasmuch as the limited capabilities of today's robots constitute a serious obstacle to full solution of the problem of freeing human beings from the necessity of direct participation in the production process. The level at which work is being undertaken on the development of intelligent robots is one of the characteristic indicators of a country's overall scientific and technical potential.

/The third basic task is to plan expansion of the sphere of application of robotics systems./ They will be needed in other branches of the national economy besides machine building, branches such as the mining, petroleum and gas industries, metallurgy, construction, transport, agriculture, services, medicine etc. Specialists calculate that in the mining industry, for example, drilling robots will not only sharply increase (by no less than two-threefold) the productivity of mine labor, but will also make for a radical improvement in the working conditions of hundreds of thousands of workers. There are similar prospects for other branches. This will create a substantial reserve of labor resources and add new impetus to the drive to intensify industrial production throughout the national economy.

/A fourth task consists in improving the training provided personnel responsible for the introduction of robots in our national economy./ The development of robots and robotized systems cannot be divorced from technology. It would therefore be to advantage to form R&D groups in those of our technological institutes primarily responsible for the mechanization and automation of those industrial production processes employed within the branch. In arriving at an integrated solution to the problem, this would make possible the optimum utilization of industrial robots and manipulators together with other means of automation.

When it comes to series production of robots and manipulators, we cannot orient ourselves solely toward the construction of new enterprises specializing in this kind of production. This approach would freeze efforts to find a solution to the problem for at least the duration of the five-year plan and require unjustifiably large material expenditures. During the years immediately ahead we must depend upon the utilization of existing facilities. It is possible that these will require some redesign and modernization and that production of certain items performing similar functions but which have now become obsolete (in part because of the appearance of robots) will have to be discontinued. Despite the degree of technical innovation they represent, industrial robots as objects of production require no special production processes or technologies. They can be fabricated by virtually any machine-building facility, especially given interbranch cooperation on the standardized components involved.

There are now more than 150 firms throughout the world engaged in the development and fabrication of robots and manufacturing more than 200 individually designated items. The vast majority of the design bureaus involved employ no more than 150-200 people and themselves constitute organizational components of larger firms engaged in the development and manufacture of other products in addition to robots. On the basis of extensive cooperation (frequently international), robots themselves are now being fabricated in general-purpose machine-building facilities along with other products (a separate usually being set up to accomodate robot assembly operations). We are currently seeing individual regions of a country beginning to adopt this approach.

In accordance with CPSU Central Committee decree and on the basis of experience with the target-program approach, we will be developing our domestic robotics over the period extending through the Eleventh Five-Year Plan and on up to 1990 in accordance with an integrated national program. This will be complemented by regional programs taking local conditions into account.

All these measures will be able to accelerate the pace of our work in robotics as an integrated interbranch task and at the same time as a problem novel from the scientific point of view, so that by the end of the Eleventh Five-Year Plan period we will have become a world leader with respect not only to overall robot inventory, but to its technical level as well.

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METALWORKING EQUIPMENT

MACHINEBUILDING OUTPUT INDICATOR IMPROVEMENTS URGED

Moscow PLANOVOYE KHOZYAYSTVO in Russian No 3, Mar 82 (signed to press 19 Feb 82) pp 37-46

[Article by USSR Gosplan assistant department head A. Ushakov and Doctor of Economic Sciences G. Kiperman, sector chief at the USSR Gosplan NIIPiN (Scientific Research Institute of Planning and Normatives): "On Indicators of Machinebuilding Output"]

[Text] Machinebuilding is faced with complex, responsible tasks in the 11th Five-Year Plan whose resolution must ensure production of highly-efficient, reliable machines, instruments and technological lines embodying the latest achievements of scientific and engineering thought on a large scale. The 26th CPSU Congress anticipated outstripping rates of growth in machinebuilding output as compared with industry as a whole.

All the efforts of machinebuilding workers must be directed towards resolving these tasks. It must be facilitated by improvement in the economic mechanism, including bringing the system of plan indicators into accord with modern requirements. Improving physical and cost indicators, which are the basis of the output indicators system, is of great importance. As is known, calculations of labor productivity, return on capital, materials-intensiveness, net cost and others are based on them.

We first of all need to improve output physical indicators. In recent years, their role has been diminished: indicators of volume and rates of growth in commodity output have prevailed in evaluations of the work of ministries, associations and enterprises. But consumers need specific machines, instruments and technological lines capable of performing specific functions in the production process and possessing properties which are reflected in physical indicators.

In accordance with the 12 July 1979 CPSU Central Committee and USSR Council of Ministers Decree "On Improving Planning and Strengthening the Influence of the Economic Mechanism on Improving Production Efficiency and Work Quality," necessary changes are being made in the system of physical measures on the basis of extensive use of scientifically substantiated technical and economic indicators reflecting efficiency, quality and other product consumer features. We are changing over to planning equipment production on the basis of an expanded products list in units of measure which more fully reflect its productivity and other economic properties.

In working out the 1981-1985 five-year plan, particular attention was paid to product physical measures (see: D. Ukrainskiy, "Planning Output Production in Physical Terms," PLANOVOYE KHOZYAYSTVO, No 10, 1980, p 49). However, it is not easy to substitute one measure for another. It entails changes in planning, normative and statistical documentation, as well as in material balances and production-capacity balances, that is, it requires much additional work. Nonetheless, objective difficulties cannot serve as justification for the slowness which the ministries and other management links have displayed in improving physical measures.

Steps to improve physical measures have their own specifics in machinebuilding branches, but there are also directions of this work which are common to all machinebuilding:

replacing measures which never or inadequately reflect item consumer properties with other physical measures which do (or more fully) reflect these properties and the technical-economic parameters of the items;

using two physical units of measure which as a whole reflect the amount of output and its most important consumer properties and its production-technical designation, units which can most appropriately be used as part of a complex including unit and parametric measures, as for example, number of units and their total power;

use of conditional physical measures established on the basis of conversion factors and reflecting one or several product parameters.

Whenever possible, it is appropriate to establish plan assignments in complete sets (complexes, technological lines) in order to better meet the demand. Sometimes, cost measures (in constant prices or in net output normatives, as millions of rubles) can be used together with units of weight (tons) when planning the production of machinery and equipment. This is effective given the simultaneous use of a second approved technical-economic parameter (productivity, weight of raw material processed per unit of time, throughput capacity and others). In a number of branches of machinebuilding, we need to review the groupings of machines, machine tools and equipment in use, to break up the extremely aggregated, nonhomogeneous groups and, in individual cases, change grouping criteria (the bases of the groupings).

Jointly with USSR Gosplan branch departments, all the machinebuilding ministries have improved physical measures in conformity with the 12 July 1979 decree. The most successful has been that of the Ministry of Electrical Engineering Industry. At the time the decree was promulgated, conditions had already been created here for its successful implementation, the dominant portion of the output products list had been reviewed, positions for which the measures did not reflect consumer properties had been revealed, proposals on replacing them had been prepared and corresponding calculations had been made for planned and actual production volumes. This permitted substantial improvement as early as the 1981 plan in the system of physical measures for electrical engineering industry output.

Jointly with the USSR Gosplan branch department, the ministry found opportunities for using measures which best meet public interests and take into account both production opportunities and the needs of consumer branches (the USSR Ministry of Power and Electrification and others). In this regard, attention was called to the trends in technical progress and prospects for branch development.

The measures previously used for a number of products-list positions were replaced by new ones which help improve the economy of manufacturing the output and the effectiveness of its use. For example, the release of contact conductors was previously planned in 1,000 tons, and now it is planned in 1,000 kilometers, which corresponds better to the tasks of making their production and consumption more efficient; power cables were previously planned in 1,000 kilometers and tons, but the second measure has now been replaced by 1,000 kVA.

This work has continued in 1981. An analysis was made of output measures in cable industry and other subbranches with consideration of the functions performed by the items for the customer. It was established, for example, that planning the release of control cable in 1,000 kilometers does not stimulate increasing the release of the compound cable needed by consumers. A second measure, 1,000 kilometers of cable calculated as single-strand, was therefore proposed.

For long-distance communications cables whose basic function consists of transmitting information (telephone conversations, telegrams, television and radio broadcasts), the existing physical measure, kilometers, did not interest the producer in ensuring that cables carried a large amount of information. An additional physical measures, channel-kilometers, was therefore proposed for this output. It will describe not only the length of the lines of communications, but also the number of information channels which each kilometer will carry, that is, the quality with which the product performs its primary function. The proposed physical measure is especially important for long-range and long-term planning, inasmuch as it can be used to track the influence of scientific and technical progress on branch development.

The system of physical measures in the electrical insulation materials subbranch requires improvement. Their production is planned in tons, while that of varnished cambric is planned in 1,000 meters. At the same time, of basic significance to the consumer is the surface area of both the electrical insulation materials and the varnished cambric. The "Informelektro" scientific research institute therefore proposed switching over to planning production of the indicated items using a new measure, square meters.

Varnished cambric prices are for square meters in the new wholesale price list instituted as of 1 January 1981. This permits reducing the number of items in the price list from 98 to 42, since prices previously calculated per running meter changed under the influence of two parameters, thickness and width, while those calculated per square meter are influenced only by thickness.

The production of machines for rail-less electric transport is planned in units, which does not meet the demands of technical progress. But we cannot reject this measure , inasmuch as it is needed in planning distribution, calculating net cost and shaping wholesale prices. It is therefore appropriate to introduce a second unit of measures, total productivity of the machines being produced in 1,000 tons. The use of two units of measure will block any one-sided orientation of producers towards releasing primarily large machines, which would make it difficult to optimize the structure of consumer electric-loader fleets.

The production of electric light sources is planned in units. This measure does not block technical improvements in these items. Planning light bulb production based on power would increase enterprise interest in increasing the release of high-wattage light bulbs, which would conflict with the task of saving electric power and would lead to the use of high-wattage bulbs when low-wattage bulbs would do.

Consequently, although measuring in units does not reflect the consumer properties of electric light bulbs, it is premature to reject it. But inasmuch as the lighting and electric parameters of light bulbs are not reflected in the "units" measures, it is appropriate to introduce a second measure for light sources, lumen-hours or, for convenience, megalumen-hours. Using a light-energy indicator as a physical measure will help lower materials and labor expenditures when producing light sources. In order to evaluate the effectiveness of using electric power, lumen-hours will be used, but "units" will be used to calculate demand and record the number of light sources.

We evidently cannot do without complex measures reflecting several parameters when planning the production of high-voltage apparatus. It is impossible to propose a single resolution for all types of high-voltage apparatus, as each requires special analysis. Research done at the "Informelektro" scientific research institute shows that a conventionally physical measure such as number of kilovolt-ampers of discontinuous power per second could be used for high-voltage switches, for example.

In heavy machinebuilding, the most pressing question is that of improving physical measures for metallurgical equipment production. We changed over in the 10th Five-Year Plan to planning metallurgical equipment production in cost units of measure for an expanded products list and retained the indicator of weight (in tons). This was naturally a step forward, but still not a final solution to the problem.

The fact is that the ton retained its positions in such planning documents as orders for metallurgical equipment, technical design assignments with design technical-economic substantiation and agreements between manufacturing plants and clients. Moreover, replacement of the ton by the ruble does not solve the problem of orienting the activity of labor collectives towards attaining the best end results, towards better meeting the needs of society with fewer expenditures. With the institution of the cost indicator as an approved indicator, plan fulfillment in terms of products list did not improve: in 1980, the production plans were not carried out for 37 of the 72 positions in the most important products list (given 100.3 percent marketing plan fulfillment and 100.6 percent fulfillment in terms of normative net output).

It is necessary to review the question of planning metallurgical equipment production in planned-installation sets (lines, installations, machines). In view of the complexity of metallurgical equipment, a complete set might be a finished portion of a line, mill or machine which ensures the technological efficiency of installation and which is manufactured within the planning year. This is all the more important because the hyperbolization of cost indicators (as a result of the fact that both the total production volume assignment and the plan products list positions are established in rubles) intensifies the tendency towards unjustified growth in prices. This phenomenon is especially appreciable in metallurgical machinebuilding where, due to the low level of standardization of rolling mill subassemblies, machines and mechanisms, it is not list prices which predominate but one-time prices, which have for many years now been set per ton of weight.

When planning in complete sets is impossible due to equipment features and a cost measure is required, it must be normative net output, rather than the wholesale price. This eliminates interest in the priority production of expensive items, inasmuch as meeting all order calculated on the basis of normative net output becomes relatively equally advantageous.

The ton has thus far remained the basic measure in blank production. This is one reason why there have been delays in increasing the release of castings, forgings, stampings and welded components and has negatively influenced the smoothness of operation of mechanical assembly shops and providing them with complete sets of blanks. Planning in tons leads to a situation in which the shops seek out reasons to manufacture foremost the "profitable" heavy castings and "postpone" the more complex casting to the end of the quarter, half-year or year.

Tons are used for the technical-economic indicators of procurement shops: labor productivity, return on capital, production capacities and others. At the same time, there are no insurmountable obstacles to excluding tons from among the basic indicators. Many leading enterprises have long been insistently proposing rejection of the ton as an approved indicator in both basic production and auxiliary production.

"Elektrostal'tyazhmash" association has since 1977 set the foundry production volume assignments in adjusted tons. The adjustment factors are set using normative (and not actual) labor-intensiveness for a period of five years. Their stability creates particular interest in lowering the actual weight of the castings. There is approximately equal interest in manufacturing all castings, independently of their weight, facilitating better plan fulfillment in terms of products list: whereas the cast iron plan was met by 76.1 percent in 1976 in terms of products list, the figure in 1980 was 91.9 percent.

A different solution was proposed by Novo-Kramatorskiy Machinebuilding Plant imeni V. I. Lenin: casting production assignments are set the shops in net output normatives. Since the normatives are based (as are adjusted tons) on labor intensiveness (and not weight) of the castings, there is no longer any concern for releasing primarily heavy castings and evenness in meeting machine and assembly shop orders is ensured.

There are thus proposals deserving attention. But the ministry has been slow to experimentally verify them.

In agricultural machinebuilding, improving physical measures must facilitate resolving the problems facing the branch. In reviewing the situation in agricultural machinebuilding at the November (1981) CPSU Central Committee Plenum, L. I. Brezhnev set it the task of raising the technical level and improving the reliability and durability of its machinery.

Tractor production is currently planned in units and horsepower; moreover, the branch plans outline the proportion of tractors with 100-hp or larger engines and the average tractor power. The state plan determines the release of tractors as a whole in terms of horsepower and units, but the general-purpose and skidder tractor subgroups only in 1,000 units. Agricultural machinery production as a whole is planned in millions of rubles, but individual groups and types of machinery are planned in units.

The system of physical measures which has evolved in agricultural machinebuilding does not fully meet modern requirements, inasmuch as the qualitative characteristics of the machines are inadequately reflected. The Ministry of Agricultural and Tractor Machinebuilding has been working since 1976 on using an indicator which comprehensively describes the operating and economic parameters of agricultural machinery and tractors -- production volume in conversion factors.

Homogeneous groups comprised of interchangeable machines have been formed to calculate the conversion factors. This work must be done jointly by the producer branch and the consumers of the output so as to prevent a one-sided interest in the preferential release of machinery with higher conversion factors to the detriment of others with lower conversion factors but which are still needed by the national economy. We must not permit "machine giants" by increasing the production of larger machines at the expense of medium-sized and small machines which are also needed by the national economy. The use of conversion factors must not hamper optimizing the tractor fleet structure. Enterprises and associations are obligated to carry out the plan for the entire products list. The role of the conversion factors is therefore not to place some machines (generally larger ones) in an advantageous position relative to others, but to facilitate an objective evaluation of the results of collective activity without infringing upon the interests of enterprises producing machines whose manufacture is more complicated.

Conversion factors do not replace physical measures (units and others), but supplement them. In this sense, the use of such factors complicated accounting and planning. But a complication of this nature is fully justified. The production of improved machines which better satisfy the demands of agriculture is increasing year by year, but technical progress is not reflected when it is measured in units. At the same time, conversion factors can take into account productivity growth, durability and, when necessary, other parameters.

The use of conversion factors would enable us to reveal negative factors in the operation of enterprises, associations and ministries. For example, the 10th Five-Year Plan anticipated the release of 724,300 grain drills in physical units, 958,000 in conversion factors. But 14,300 units more than were planned in physical units were actually produced, and that turned out to be 5,100 units fewer than were planned in conversion factors. Consequently, the plan underfulfillment in terms of producing improved models of drills was covered by the release of obsolete items with poorer consumer properties, which required additional expenditures of energy resources and metal and resulted in a higher demand for machine-operator personnel and spare parts. The situation is similar in harvester production. This could have been avoided had the production plan been considered carried out only given fulfillment both in physical units and in conversion factors, with mandatory observance of the average amounts of each.

Four years of experience have confirmed the appropriateness of using conversion factors. At the same time, questions requiring resolution were also revealed. In particular, the groups of interchangeable machines were not always well-arranged. In addition to power and service life, it was also necessary in a number of cases to take other parameters into account (the productivity of a tractor could be increased, for example, without increasing its power by using an automatic sowing depth regulator or other methods). At the same time, the Ministry of Agricultural and Tractor Machinebuilding experiment demonstrated in principle the appropriateness of using conditional physical measures which take into account the basic consumer properties of the machines.

"Units" has been the basic physical measure of machine-tool and tool-making industry output. The release of machine tools and woodworking units, foundry machinery, forging-pressing and other equipment is planned in them. Measuring output in units does not reflect its consumer properties and is therefore formal in nature. In spite of the fact that machine-tool building is distinguished by a high level of subject specialization, there are fluctuations in machine-tool technical-economic parameters even at individual plants (which fluctuations are naturally not reflected in the unit measure). For example, the labor-intensiveness of producing machine tools of the same type at the Moscow Jig Borer Plant fluctuated between 1,250 and 4,150 norm-hours in 1981; net cost fluctuated between 16,190 and 58,300 rubles. In spite of this, overall machine-tool production here is also planned in units. True, their cost is also planned in comparable wholesale prices by products-list group. But plan fulfillment is evaluated foremost in units, while the cost measure is auxiliary.

The release of automatic and semiautomatic lines for machinebuilding, metalworking, wood processing and furniture production is planned in complete sets. However, the proportion of such output in the branch is not high.

In the course of implementing the 12 July 1979 decree, the products list of machine-tool manufacturing output was expanded in the national economic plan. Thus, the item "including machine tools for processing items 2,500 mm or larger in diameter" was introduced to supplement the item "turning and boring lathes." Machine tools with drill diameters 50 mm or greater were detached from the "drills" group, and so forth. At the same time, individual items were eliminated from the national economic plan, in which connection the demands for corresponding items are being fully met (as for example, roofing iron rollers, machines for straightening and cutting reinforcing bar).

However, the steps taken in machine-tool manufacturing should be viewed only as the first steps in improving physical measures. The Ministry of Machine Tool Industry and its scientific research organizations have prepared proposals, some of which can be introduced and other which will require experimental verification. For example, it is being proposed that we plan the release of automatic and semiautomatic lines in complete sets and millions of rubles. The ENIIMS [Experimental Scientific Research Institute of Machine Tools] proposal that total machine-tool production be defined both in physical units and in conditional units reflecting item parameters can, we think, be introduced only after experimental verification. Prior to that verification, we should evidently plan machine-tool production in two measures -- units and millions of rubles. However, the proposals prepared still do not solve the problems of bring the system of physical measures in the branch into conformity with modern demands. Planning in units remains characteristic of the branch.

Chemical and petroleum machinebuilding is among thos branches in which the basic measure of production was the unit of weight, the ton, for a number of types of machines and equipment until recently. This related foremost to petroleum and gas purification equipment. In connection with the necessity of implementing the CPSU Central Committee and USSR Council of Ministers decree of 12 July 1979, the Ministry of Chemical and Petroleum Machinebuilding has since 1981 rejected use of tonnage as an approved indicator, having replaced it with cost: assignments for producing petroleum and gas purification equipment are set in 1,000 rubles. However, the demand that scientifically substantiated technical-economic indicators permitting consideration of the effectiveness, quality and other consumer properties of the output be instituted remains unmet.

The replacement of physical measures with cost ones does not fully solve the problem. Reporting data show that the plan has been carried out better in rubles than in tons or units. Thus, the overall 1981 plan was met by 93.9 percent in tons and 100 percent in 1,000 rubles for the "Volgogradneftemash" association, Borisoglebskiy Chemical Machinebuilding Plant and "Krasnyy Molot" plant in Tikhoretskiy. For the ministry as a whole, the petroleum apparatus production plan for 1980 was met by 93.3 percent in tons and 102.2 percent in 1,000 rubles.

The same situation obtains for output growth rates: it is higher in cost terms than in physical terms. For example, the production of gas-purification and dust-removal equipment increased 100.3 percent in tons relative to the preceding year in 1980 and 104.5 percent in 1,000 rubles.

Consequently, the changeover from planning equipment production in units of weight (tons) to setting assignments for plan products-list items in 1,000 rubles cannot be considered a solution to the problem. The national economy needs not better plan fulfillment in millions of rubles, but actual work improvement, better satisfaction of the needs of society for all types of machinery and equipment. Unfortunately, the proposals of several ministries which have replaced an effective resolution of the problem with "cosmetic" measures which create the appearance of improvement have not always been properly rejected.

The Ministry of Chemical and Petroleum Machinebuilding also has quite a few types of output which are planned in units due to sharp differences in parameters (pumps and others). The very same planning group includes pumps which differ 10-fold or more in leading parameters. Given such an aggregate, it is not hard to maneuver the products list and carry out the plan as a whole by group while failing to carry it out for many types of output within it. Analysis shows that plan fulfillment is worst for the most complex and labor-intensive items. It is no accident that the reported normative labor intensiveness of the items as a whole for each group of pumps and compressors is below planned: given equality in the planned number of items and the reported number, the proportion of the simpler and less labor-intensive items increases to the detriment of the more complex and those needed more by the customer. We need to seek out more persistently and, when necessary, to experimentally verify possible resolutions not in compliance with current provisions, which are themselves far from optimal.

In automotive industry, the most pressing problem is to improve the physical measures for bearing production. It is currently planned in units. The ministry proposes using a cost measure (1,000 rubles) as an approved measure and to make the indicator of production in units a calculation one.

We cannot agree with such a proposal, since the result might be the creation of the appearance of better plan fulfillment while the needs of the national economy are met less well in terms of bearing products lists, and especially for inexpensive bearings. It is therefore appropriate to plan bearing production in two measures -- units and rubles, considering the plan fulfilled only if it is carried out in terms of both measures. This will naturally face enterprises with the necessity of carrying out the plan strictly in accordance with the entire products list, and their work will be more complicated. But the national economy will gain, which is paramount.

The Ministry of Machinebuilding for Light and Food Industry and Household Appliances is among those branches which initiated use of normative net output (NChP) as an indicator. It is at the enterprises of this ministry that many provisions of the current methods have been worked out.

Planning the production of technological equipment and spare parts for it in millions of rubles is specific to it. With the changeover to planning production volume in NChP, the ministry has proposed planning the release of technological equipment in NChP as well. This proposal has its pluses and minuses. The positive is that attaining complete enterprise plan coordination in terms of products list with plans based on overall production volume would be achieved. But when equipment production volume is planned only in NChP, it is not possible to take that volume into account when working out equipment distribution balances. In this connection, it was decided to experimentally plan technological equipment in NChP and constant prices. In this regard, the evaluation indicator is production volume in NChP. However, plan products-list position cost measures (regardless of whether the former are expressed in wholesale prices or NChP) cannot fully replace physical measures.

Analysis shows that it is not possible to reject a cost measure of plan products-list positions, but that it is possible and necessary to limit its negative influence on production development. In order to do this, we should single out among the indicated products-list positions the largest, those which comprise a significant proportion of the items for which efficient measures reflecting their consumer properties can be used. This has to an extent already been done: bread-baking ovens, measured in units, have been singled out from among technological equipment for food industry; diffusion installations and evaporating apparatus (also measured in units) have been singled out from among equipment for sugar industry, and so forth. However, the ministry has only taken the first steps in this regard, and insufficiently systematically at that: first, it is appropriate to broaden the products list of items being planned in physical measures; second, and particularly important, we need to improve the physical measures themselves.

The Ministry of Machinebuilding for Light and Food Industry and Household Appliances has scarcely begun this work: only one position was changed in the 1981 plan -- spinning machines (in 1,000 spinning spindles or positions). At the same time, a majority of the plan products-list positions in this branch are defined in units, in spite of serious differences among them in terms of power and other parameters. For example, the use of two such measures as 1,000 units and 1,000 square meters for weaving machines would better reflect the actual situation and would facilitate the interlinking of physical and cost indicators. There are unavoidably large gaps between production volume in units and volume in rubles. The gaps close quickly when production volume is measured in cost (in rubles) and in power. True, it could be maintained that the technical documentation does not indicate the power of machine tools in terms of fabric square-meter output per hour. But if we do not change over to this indicator, initially experimentally at least, the opportunity for using it will never appear.

Weaving machines are only a partial example. The products list of the Ministry of Machinebuilding for Light and Food Industry and Household Appliances contains dozens of positions being planned in rubles or units which do not reflect the technical and economic parameters of the items. They include beaters and drawing frames, flow lines for flax and hemp, compressors and evaporators for home refrigerators, and other items. This is to be explained not by the features of branch output, by insufficient attention to this question.

The Ministry of Machinebuilding for Light and Food Industry and Household Appliances has prepared proposals on breaking up groups and introducing improved physical measures, but they do not fully meet the needs of customers such as the Ministry of Light Industry, Ministry of Food Industry and others. However, it is precisely their interests which must be of decisive importance in questions of measuring the release of items for specific consumers.

The Ministry of Construction, Road and Municipal Machinebuilding, Ministry of Machinebuilding for Animal Husbandry and Fodder Production and Ministry of Machine Tool and Tool Building Industry have not worked actively enough to improve physical measures; the Ministry of Automotive Industry has been slow in expanding its research. At the same time, more than two years have passed since adoption of the decree on improving the economic mechanism, and it is time now to speak not of progress, but of results in carrying out this portion of it.

Simultaneously with improving physical indicators, we are changing over to planning machinery and equipment production in an expanded products list. The purpose of this work is to better meet the demands of the national economy for progressive types of output.

In our opinion, the changeover to planning machinebuilding output in an expanded products list does not signify that the number of positions being approved in the national economic plan for each branch or ministry must increase substantially. It is entirely possible to changeover to planning production in an expanded products list without appreciably increasing the total number of approved positions; in individual instances it can even be reduced. This can be achieved in two ways.

First, by simultaneously excluding from the products list in the national economic plan positions previously included in it for reasons which have lost their importance. For example, an item might have been in short supply in the past, but the demand for it is now being met. The national economic plan products list must be dynamic and mobile. Of course, the most important types of output which determine the branch profile and its role in meeting social needs are now and will in the future be anticipated in the national economic plan products list (tractors, motor vehicles, diesel locomotives, diesel engines, excavators, compressors, and so forth). But there are also quite a few positions included in the products list for reasons of a temporary nature.

Second, in spite of the inclusion in the products list of a large number of new positions, the development of production planning for complete sets is becoming an increasingly significant factor countering expansion of the products list. We can count on such planning leading to a reduction in the total number of positions in the centrally-approved products list of machinebuilding output, inasmuch as each complete set will include much different equipment, individual types having previously been included in the products list in independent positions. For example, a complete set (flow line) to produce 450,000 tons of ammonia per year is comprised of 193 pieces of chemical equipment, 39 pieces of petroleum apparatus, 16 compensators, 76 pumps and compressors, and so on. Of course, reducing the products list will occur only if the overwhelming majority of certain types of machinery, apparatus and equipment is part of complete sets and only if it is not necessary to anticipate in the plan the parallel production of individual machines which are parts of complete sets. Their production will be anticipated in the USSR Gossnab and ministry products lists.

Planning in complete sets will meet the task of orienting enterprise and producer-branch activity towards attaining the best end results. And it must first of all meet the interests of consumers receiving the equipment which is more ready for operation. We evidently need to determine a list of products of each ministry whose release must be planned in complete sets, and to do so in a centralized manner.

However, the "complete set" physical measures does not, in and of itself, describe the consumer properties of equipment. It is therefore necessary to introduce a second measure, the leading parameter of the complete set, line or unit (as, for example, number of installations to produce ammonia, in units, and their capacity, in

1,000 tons). This combination of measures will facilitate better satisfaction of the needs of client enterprises and orient manufacturers towards improving the technical and economic parameters of their output.

A certain amount of experience has been accumulated in a number of ministries, enterprises and associations, and the USSR Gosplan in improving machinebuilding output indicators. The task is to complete this work in the very near future and use the new indicators when working out the 1983 USSR economic and social development plan.

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METALWORKING EQUIPMENT

BSSR MACHINE-TOOL OPERATION SHIFT INDEX DROPPING

Minsk PROMYSHLENNOST' BELORUSSII in Russian No 11, Nov 81 (signed to press 20 Oct 81) pp 9-12

[Article by V. Mayevskiy, machinebuilding sector chief at the NIIEMP (not further identified) attached to the BSSR Gosplan: "Surplus Machine Tools"]

[Text] At the present stage of economic development, exceptionally important significance is being given to improving the use of fixed production assets, and foremost of equipment. Expanding the release of output, improving labor productivity and saving resources depend in considerable measure on resolving this task.

An analysis of the equipment use level achieved in the last five-year plan testifies to significant reserves which have in a number of instances been created due to overlooked opportunities. Actualization of these reserves does not require any significant capital investments, inasmuch as the losses have been caused by oversights in enterprise production-economic activity, by an insufficiently high organizational level of production management. Nothing else would explain the fact that during the 10th Five-Year Plan, the shift index of equipment operation in machinebuilding not only failed to increase 20-30 percent as was required, but even decreased. Thus, according to survey data, it was 1.50 in republic machinebuilding in 1980, as against 1.56 in 1975. The shift index in auxiliary production was 7-10 percent lower than in basic production, but auxiliary production is where about a third of all metalworking equipment is concentrated. The deterioration in the shift index of machine tool and machinery operation results from the growing proportion of inactive equipment, which rose from 10.9 percent in 1975 to 12.1 percent in 1980, that is, one in every eight or nine pieces of installed equipment stood idle. Whole-shift idle time was also high, nine percent of the machine-tool shift time worked (excluding unscheduled operation). The lower shift index was one factor in the 3.3-percent reduction in return on capital.

What specifically caused losses this high? Some 53-58 percent of the whole-day equipment down time was due to shortcomings in production organization (understaffing, lack of raw and other materials and tools, surplus machine tools and machinery). Characteristically, last year, idle time associated with a shortage of machine tool operators increased sharply. This testifies to the growing disproportion between the number of workers and the number of workplaces serviced by them. Incidentally, if effective steps are not taken, the more so given the demographic situation which has developed, the situation might be aggravated even more.

The only way of overcoming the disproportion is to introduce advanced technology, to mechanize and automate production, and to make extensive use of multimachine servicing and combining occupations. We should point out the machine tool operators reserve in auxiliary production. Freeing just 15 percent of the auxiliary workers and requalifying them as machine tool operators would ensure a rise in the equipment shift index in basic production to approximately 1.7 and would significantly reduce idle time. (For reference: auxiliary workers currently comprise approximately 40 percent of those employed in republic machinebuilding.)

The introduction of progressive forms of labor organization at machinebuilding enterprises requires serious preparatory work. It must rely on worker initiative and material interest. In individual instances, introducing progressive forms of labor organization forces a rearrangement of equipment. It should be noted that the leading enterprises have achieved rather good results in this regard. Thus, the number of machine tool operators servicing several machines more than tripled during the five-year plan at the Borisovskiy Automotive and Tractor Electrical Equipment Plant. About 400 people have combined occupations, or 9.9 percent of the total workforce. Bonuses are 10 percent higher for operators of several machines and additional free food is issued them. These and other measures enabled the enterprise to raise the shift index by 7.5 percent (to 1.71 in 1979, for example). As we see, the causes of equipment inactivity resulting from understaffing can be entirely eliminated.

Losses due to the availability of surplus, and sometimes even unnecessary, machine tools and machinery at enterprises are still high. These losses can be avoided by redistributing equipment among enterprises and construction sites. For an optimum redistribution, we think it necessary that:

information on the presence of unneeded machine tools be disseminated nationwide and enterprises report surplus equipment to the appropriate organizations;

the functions of managing this process be centralized within the USSR Gossnab and territorial material-technical supply agencies;

branch plans for redistributing equipment formerly in use be linked to plans for distributing new equipment and forms be anticipated for marketing machine tools and machinery enterprises do not need at reduced prices;

methods be worked out for determining surplus equipment as applicable to specific production conditions.

We should add to the above that the enterprises themselves are sometimes not interested, in cost-accounting terms, in accelerating the marketing of surplus machine tools and retain them "for emergencies." Of course, that is not always the case. The leading enterprises are constantly concerned about promptly withdrawing equipment which does not ensure labor productivity growth and increased return on capital, and they try to accelerate the replacement of obsolete and obsolescent equipment. A certain amount of experience has been accumulated, for example, by enterprises in Leningrad, by the Borisovskiy Automotive and Tractor Electrical Equipment Plant and by the Minsk tractor and automotive plants.

Still, there is quite a bit of surplus equipment. Thus, according to a May 1980 survey, the Orshanskiy Tool Plant had 55 unneeded machine tools, Mogilevskiy Primary Data Preparation Installations Plant -- 13 unneeded forging and pressing machines and "Bobruyskfermmash" PO [production association]-- 21 unneeded machine tools, and so on (upwards of 400 units at all republic enterprises). By the way, the number of surplus machine tools at "Bobruyskfermmash" has been constantly growing. By the end of the first half of this year, 85 had already accumulated. And quite a few of the machine tools in the "unneeded" category are progressive types. And if consideration is given to the fact that the lead enterprise, the Bobruyskiy Fertilizer Application Machinery Plant, became operational comparatively recently, the presence of this much surplus equipment and such low equipment use indicators testify to an absence of proper attention by the technical and economic services of the association to production organization and monitoring operation of the machine-tool fleet. Association enterprises have not worked out measures on improving the effectiveness of fixed production assets use. Is it surprising that the return on capital continues to drop here?

So-called regulated equipment down time caused by technical and production necessity remains impressive (about a third of all whole-day idle time in republic machinebuilding). It is practically impossible to eliminate it. The reference can only be to reducing the time involved in planned maintenance of the machine-tool fleet and in up-dating it, to intelligent reserve equipment planning. The amount of equipment being repaired can be reduced by introducing progressive types of repair and improving its quality. But the state of affairs in equipment repair and servicing is being improved slowly. The reasons are decentralization, insufficient equipment repair mechanization and specialization, insufficient and poor-quality spare parts and subassemblies, interruptions in supplies of tools and materials, and shortcomings in the technology and organization of labor and management. As a consequence, not only are repair schedules lengthened, but subsequent machine tool and machinery operating reliability is also inadequate. The cost of major overhauls is high. It often exceeds the cost of a new machine tool. There are a variety of ways of solving the problem, but they all must be oriented towards eliminating the enumerated shortcomings.

It is known that calculations used to determined shift index and capacity deal only with machine tools, machinery and equipment, that is, the evaluation of the effectiveness of these indicators is characterized by use of the exact same object, available equipment. Consequently, if one abstracts from disproportions in the structure of the equipment operating time the machinery-intensiveness of the production program, the indicators of capacity and shift index are directly proportional. In practice, use of the annual average capacity of machinebuilding enterprises is quite high, at least 92-95 percent, but the shift index, in republic machinebuilding for example, is 1.50. Thus, the reserve for increasing equipment operating time is covered by the capacities use reserve.

What is the reason for this overstated reserve in capacities calculations? There simply is no single methods approach to substantiating production capacity. The interbranch instructions on determining it as applicable to machinebuilding plants takes into account only the leading group of equipment, and not the entire stock of machine tools. As a result, the actual amount of equipment greatly exceeds the number of machine tools and machinery included in the production capacity calculation. At the same time, the instructions permit the free choice of the leading subdivision (shop, sector, equipment group), irrespective of level of equipment progressiveness. Therefore, a large amount of complex and more-productive equipment does not get into the calculated fleet of machine tools and machinery limiting the throughput capacity of the enterprise and turns out to be underloaded. Some types of automated equipment, and especially machine tools with numerical preset control and large, heavy, single-purpose, electro-erosion and ultra-sound machine tools, are being operated no better, or even worse, than ordinary machine tools.

Thus, the choice of a leading link and equipment composition when calculating capacities, if done at the enterprises' discretion, creates prerequisites for retaining or even intensifying disproportions as a result of more frequent change in the list of products being produced as compared with the relatively stable equipment fleet and forms of production organization. Moreover, these disproportions can be sharply exacerbated in connection with failures to meet delivery schedules for blanks, parts and subassemblies under cooperative agreements, by above-plan assignments, by unexpected machinery and machine tool malfunctions, and by a number of other organizational and technical breakdowns.

The demand of the times is to achieve an evenly taut load on the leading groups of equipment or production sectors through planned regulation of the composition of the available tools of labor. We also need to improve methods of calculating capacities along the line of choosing evaluation criteria, which must be not the cost of the maximum possible release of output, but the productivity of the machine tools and machinery being used and their potential with consideration of the development of normatives for the leading groups of equipment, which will permit obtaining optimum values when calculating capacities. Of course, the creation of optimum capacities for maximum equipment loads is a complex matter requiring first of all the development of economically substantiated optimum enterprise capacity arrays and optimum technical-economic indicators for them. The experience of individual branches of machinebuilding and a number of enterprises testifies to the fact that such work can be done successfully and that tangible results can be obtained.

Given persistent disproportions in equipment loads, it is important to organize machinebuilding enterprise cooperation in using production capacities. The complexities of cooperation in using metalworking equipment are obvious. There is a lack of centralized information on the available equipment use time for specific types of equipment. Some managers are afraid to show their reserves. The legal bases of such cooperation have not been designated. Under such conditions, the functions of organizing and monitoring capacities cooperation must evidently be assumed by the ministries and departments and by territorial planning agencies.

And one other problem. In the 10th Five-Year Plan, machinebuilding ministries communicated shift index improvement assignments to their enterprises. This was the start of the development by plant technical and economic subdivisions of steps to improve equipment use. As a rule, they were aimed at attaining the planned shift index indicator, linking it to the indicators of other sections of the state plan in a unified system, at a better-substantiated capacities calculation and a reduction in equipment idle time. However, a majority of the enterprises still do not have such measures. It is no accident that some republic machinebuilding enterprises had a sharply lower shift index in 1980 as compared with 1977. Thus, the Pinsk Forging-Pressing Automated Lines Plant had a drop in this indicator of from 1.36 to 0.71; "Gomel'kabel'" plant -- 1.56 to 0.90; Luninetskiy Agricultural Electric Motors Plant -- 1.09 to 0.85; Minsk Automotive Plant -- 1.65 to 1.37, Borisovskiy Tool Plant -- 1.62 to 1.39.

Instituting a planned shift index level is of great national economic importance. However, it should be stated that the mechanism for planning it is not yet fully worked out, for a number of reasons. Thus, there are no single methods recommendations on analyzing and calculating the shift index. Planning is not being preceded by the development of shift index normatives. Weighted-mean shift index factors as a function of type of production and amount of existing equipment have not been developed either. It would be appropriate to set plan assignments for this indicator which indicate the factors which will ensure that this value is attained. Enterprises and their workers are not always stimulated to put a high load on the available stock of machine tools and machinery.

In our view, bringing individual equipment use reserves into play through the measures being proposed here will facilitate outstripping growth in machinebuilding output and a higher return on fixed production assets.

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METALWORKING EQUIPMENT

MINSK BROACHER DESIGN QUALITIES NOT ACTUALIZED IN OPERATION

Minsk PROMYSHLENNOST' BELORUSSII in Russian No 2, Feb 82 (signed to press 18 Jan 82) pp 32-34

[Article by A. Astrovskaya, junior associate at the Economics Institute of the BSSR Academy of Sciences: "Machine Tools With Excess Quality?"]

[Text] Ten years ago, the Minsk Production Association to Produce Broachers and Shearers imeni S. M. Kirov developed and mastered the production of a new system of broachers. Many of the models were the equal of analogs made by well-known foreign companies in terms of technical level and quality and even surpassed them in terms of a number of technical-operation parameters. Thus, for example, the model 7B66 vertical broacher exceeded the working speed of models manufactured by the best companies in the FRG and USA by 28 percent, the main drive power by more than a third, and productivity by a quarter. Or take the 7B65. It was 80 percent more productive than analogs being manufactured in the USA and Japan. Equipped to feed parts in and out automatically, it could be built into automated lines. Other models were also successful. Nearly all were awarded the state Badge of Quality for modern design and high level of technical-operation parameters achieved. One cannot but be proud of this. However, the reference is to more than the merits of the indicated machine tools.

Let us recall that the annual economic impact of the 7B56 was to have been 3,255 rubles, and that of the 7B66 -- 800 rubles. Were to have been, but were they? And in general, does the production of more progressive output always guarantee an economic impact in their operation?

In order to answer these questions, we analyzed the results of operation observations of vertical and horizontal broachers the association's special design bureau made at consumer enterprises.

It disclosed that the working speed was 2-5 mm per minute in more than half the cases and that only 8.5 percent of the equipment surveyed had a working speed of 12 mm per minute. Or take travel. It was primarily 500-1,600 mm, given a designed figure of 2,000 mm. In many instances, individual subassemblies were not used. Specifically, the broach feed and removal mechanism was not used on one of every two 7B55's and on one of every five 7B56's. Incomplete use of the technical advantages of a number of machine tools was also established for other operating parameters: machining precision class, finish smoothness, and so on. Or this. Nearly a third of the broachers surveyed had technical use coefficients of only 0.2 to 0.5, slightly more than half were 0.6 to 0.8 and only 17.3 percent of the equipment was 0.85 to 0.95. The shift index was also low. Nearly half of all machine tools were operated in a single shift and 45 percent were operated in two.

All this cannot but be reflected in the main indicator, productivity. The actual productivity of such models as the 7B56, 7B 66 and 7B65 is considerably below the designed level at all machinebuilding enterprises surveyed, the Minsk tank car and tractor plants, "Gomsel'mash" and others.

Why? The main reason for incomplete use of the broachers was that their productivity was generally higher than that of other types of machine tools in the same technological sequence. As a result, the economic impact actually obtained by the consumer deviates substantially from the impact calculated at the technical assignment stage. And sometimes it is not ensured at all.

It follows from all the above that the quality of output at the pre-planning and planning stages is one aspect of the matter, but the level of quality and effectiveness realized by the consumer is an entirely different one. The high operating parameters designed and manufactured into machine tools are a necessary, but not the sole, condition for obtaining the economic impact. The economic appropriateness of improving product quality is determined not only by its design data, but also, and in significant measure, by how it will be used, by the extent to which the technical advantages provided it at the design stage are realized.

This problem has taken on particular urgency now that we are in the process of intensively updating the machine-tool fleet, now that expensive machine tools occupy an increasingly high proportion in the equipment structure. Therefore, along with improving the quality of the equipment being produced, it is equally important that we increase the effectiveness of its use and search out ways of bringing the realized level of machine-tool quality as close as possible to the designed level.

Unfortunately, the economic leadership practice which has evolved by no means fully takes into account the features of this particular problem, which is delaying its comprehensive solution. Thus, in quality control work on machine tools being manufactured, primary attention has been concentrated on design and manufacture. The area of operation, where the quality level is actualized, has almost dropped entirely out of the quality control system. Here, quality control is represented only by individual elements (basically operation observations by machinebuilding planning-design organizations). Need it be said that these observations alone cannot provide a proper understanding of the range and causes of deviations in operating parameters when machine tools are being used. First, the range of enterprises at which such studies are made is limited. Second, the economic aspect of equipment use results is not an area of competence for those making the studies. Moreover, even these limited methods of studying equipment operation are used by far from all machinebuilding organizations.

Let us note that considerably more attention is paid to studying machine-tool operation at the association imeni S. M. Kirov than at other enterprises. And this has made it possible to run technical-economic analyses on the use of individual models of broaching equipment. Proper consideration of this has not been set up at a majority of the machinebuilding enterprises, though.

The negative consequences of underestimating the operation sphere in the quality control system are reflected first of all in the completeness and quality of KS UKP [comprehensive quality control system] information. For example, it is known at every management level what volume of output has been produced with the state Badge of Quality, what future steps should be anticipated to increase the release of output in the highest quality category and what economic impact is anticipated from the implementation of a particular measure. However, who can say how this output is actualized, what economic impact is achieved when it is operated and if that impact corresponds to the designed impact? And if it does not, why? What steps should be taken so that efficiently designed output provides that same efficiency when it is consumed? The enterprises do not have these data. Moreover, no one, neither the designer nor the manufacturer nor the consumer, is held either morally or materially responsible if the national economy fails to receive the full economic impact from operating new equipment.

Inasmuch as manufacturers and consumers are very poorly informed as to the advantages and shortcomings of machine tools being produced, the necessity of improving their technical-operation parameters is often substantiated only approximately. Changes in particular product parameters sometimes become ends in themselves, as does the mastering of new models. In many instances, consumer demands are ignored, which consequently impacts on equipment use. In striving to create machine tools with a wide range of operating possibilities, designers resort to technical improvements which increase expenditures, and consequently prices, although their innovations are not used in the course of operating the machines. At the same time, enterprises are often forced to acquire the machine tools offered them, for want of machine tools with the qualities they need.

In order to create as early as the design stage equipment variants which surpass modern models and at the same time ensure the absolute minimum economic effectiveness of operation in terms of technical and economic indicators, we need to bring into play such levers as will make the interests of designers, manufacturers and consumers depend on the results of equipment operation. Technical-economic evaluations of product quality at the operating stage could be an important measure facilitating this. The current practice of reducing the technical and economic substantiation of new equipment models just to evaluations in the design and manufacture areas does not, as we have seen, orient designers towards ensuring real efficiency. The technical-economic substantiations being used without links to economic evaluations of similar equipment at the consumer are most often oriented towards justifying the technical variant adopted. As a result, designs are created at the planning stage which are effective in terms of the substantiation done, but which wittingly do not permit ensuring the economic impact during operation.

The lack of indicators evaluating results of using new and improved machine tools in the quality control system first of all do not arouse consumers to seek out ways of using them efficiently and shape in them a purely consumer, rather than state, approach to equipment use. And payment for fixed production assets cannot (due to its small size) be an effective lever for improving equipment use effectiveness.

Supplementing the quality evaluation of a design-prototype machine tool with an evaluation based on realized quality level indicators considerably simplifies the search and increases the effectiveness of the new-model variants being adopted; it also enables us to make appropriate adjustments in the aggregate of consumer properties of the equipment precisely from positions of economic expediency.

Evaluating machine-tool quality in operation would provide more reliable and complete information on what they constitute and would permit revealing the most effective ways of improving them as applicable to specific production conditions. In this regard, not all types of equipment in operation should be subjected to such evaluation, but primarily machine tools with the state Badge of Quality, those with numerical preset control, unique equipment, and so on.

Successful resolution of this task will naturally depend on the objectivity with which the evaluation is set up, on how fully all the advantages and losses connected with creating and operating output with a higher level of quality are taken into account. Essentially, the evaluation must be a unique filter which excludes the possibility of designing and putting into production output which is substandard or inefficient.

Planning organizations currently evaluate machine-tool quality on the basis of a comparison of individual operating features with the corresponding features of base models. But, as is known, equipment quality is described by a very large number of parameters, so such an approach does not exclude overestimating individual product qualities to the detriment of others which are sometimes more important at that particular moment. Moreover, it is not only complicated to evaluate quality in this manner, but in a majority of cases infeasible as well, since no unambiguous conclusion can be drawn as to the overall quality level.

At the same time, there are quite a few methods developments which permit evaluating quality more simply and sufficiently reliably, methods which combine technical advantages and economic resultancy. One, for example, anticipates using the indicator of relationship of actualized machine-tool productivity to total expenditures on its production and operation. This indicator, which is in the All-Union State Standards, has been called the "integral" quality indicator. Using a generalizing evaluation indicator does not exclude evaluation and analysis of individual machine-tool properties. Rather, it must supplement and be closely linked to them. All this enables us to determine the primary thing, which is: under the influence of what factors do the dynamics of the generalized level of quality evolve?

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